South Bay Salt Ponds Initial Stewardship Plan
Draft Environmental Impact Report/Environmental Impact Statement
Technical Appendices

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Submitted by:

California Department of Fish and Game

United States Fish and Wildlife Service

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South Bay Salt Ponds
Initial Stewardship Plan

June 2003

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1.0 Project Overview

Through this plan, the South Bay Salt Ponds Initial Stewardship Plan (ISP), the California Department of Fish and Game (DFG) and U.S. Fish and Wildlife Service (USFWS) will operate and maintain the ponds prior to the development of the long-term plan. Detailed design studies involving technical specialists in water quality, hydrology, soils, engineering and biology/wetland ecology were used to prepare the ISP, which has the these objectives:

- Cease commercial salt operations
- Introduce tidal hydrology to ponds where feasible
- Maintain existing high quality open water and wetland wildlife habitat, including habitat for migratory and resident shorebirds and waterfowl
- Assure ponds are maintained in a restorable condition to facilitate future long-term restoration
- Minimize initial stewardship management costs
- Meet all regulatory requirements, especially discharge requirements to maintain water quality standards in the South Bay.

The ISP describes new water control structures, technical support for the desired changes, operational management of surface water and proposed discharge salinity levels, routine maintenance and monitoring protocol to direct adaptive management.

Changes to existing operations include:

- Circulating bay waters through reconfigured pond systems and releasing pond contents into the Bay. The plan will require installing new water control features, consisting of intake structures, outlet structures, and additional pumps to maintain existing shallow open water habitat.
- Managing a limited number of ponds as seasonal wetlands, to reduce management costs and optimize habitat for migratory shorebirds and waterfowl
- Managing different summer and winter water levels in a limited number of ponds to reduce management costs and optimize habitat for migratory shorebirds and waterfowl.
- Restoration of three ponds to muted tidal or full tidal influence.
- Managing several ponds in the Alviso Complex as "batch ponds," where salinity levels would be allowed to rise in order to support specific wildlife populations.

1.1 Context

The San Francisco Bay has been called an ecological treasure. Its sweeping wetlands once served as a magnet for waterfowl and shorebirds. Shorebirds – some now on the verge of extinction – were common as coots. Historic pictures tell the story of the Bay producing thousands of wild salmon.

Today, the estuary is still home to a wide variety of wildlife species – over 250 species of birds, some 120 species of fish, 81 types of mammals, 30 kinds of reptiles and 14 species of amphibians. In addition to attracting wildlife, the estuary's wetlands play a critical role in preserving the water quality in the bay by filtering pollutants, preventing shoreline erosion and easing the impacts of periodic flooding. Some 40 percent of California's water flows into the estuary, which includes the Bay and the Sacramento-San Joaquin Delta.

The salt ponds that ring the South Bay are readily visible to commuters driving across bridges or visitors flying into local airports. These multicolored ponds often provide the first impression tourists have of the San Francisco Bay. The acquisition of the salt evaporation ponds represents an unprecedented opportunity to restore the degraded estuary.

Embarking on a once-in-a-lifetime opportunity, the DFG and USFWS recently acquired 16,500 acres of industrial solar salt ponds and associated salt-making rights in the bay from Cargill Salt. Approximately 15,100 acres of this is in the South Bay, and approximately 1,400 acres is in the North Bay. Purchase of the ponds represents a down payment on a multimillion-dollar commitment to restore, preserve and enhance former tidal salt marsh habitat for fish and wildlife in the South Bay. Acquisition and restoration of the ponds represents the largest tidal wetlands restoration project on the West Coast.

The Cargill solar salt production facilities cover some 26,000 acres, ringing the shoreline of southern San Francisco Bay. Prior to the sale, Cargill owned 14,760 acres and controlled the mineral rights to produce salt on the 11,430 acres of ponds owned by the U. S. Fish and Wildlife USFWS. With the sale, the DFG now owns 5,500 acres of "Baumberg Complex," located between the San Mateo Bridge and the Alameda Creek Flood Control Channel and 1,400 acres at the "Napa Plant Site" in the North Bay. (Note that the Napa ponds are not included in this ISP.) The USFWS owns and will manage the 1,600 acres of West Bay Complex, located on both sides of State Route (SR) 84 west of the Dumbarton Bridge and 8,000 acres of "Alviso Complex," located from Charleston Slough east around the South Bay to the Union Pacific Railroad (UPRR) line north of Mud Slough. Cargill will continue to operate the remaining commercial salt ponds in South San Francisco Bay.

The long term goal of the DFG and the USFWS is to restore the ponds into a mosaic of habitats, including tidal wetlands, saline ponds and seasonal ponds to benefit threatened and endangered and migratory and resident breeding species. Many of these ponds and the adjacent marsh have become important habitat for threatened and endangered wildlife, such as for the California Clapper Rail, Western Snowy Plover, California Least Tern and Salt Marsh Harvest Mouse. Planning and design for the long term restoration and operation is projected to take approximately five years and will require additional time to implement. The ISP will be in place during the period needed to plan and implement the long term restoration plan.

1.2 Location of Project

The Cargill Salt production facilities currently ring the shoreline of southern San Francisco Bay, on the margins of Alameda, Santa Clara and San Mateo counties. Cargill's South Bay facilities consist of five regional pond complexes: Baumberg, Newark #1, Newark #2, Alviso, and Redwood City. The ISP includes the Baumberg, Alviso (with the exception of Ponds A4 and A18), and West Bay complexes (See Figure 1-1). Cargill Salt will continue salt-making operations on the Newark #1 and Newark #2 complexes and at the Redwood City plant site and therefore are not included in the ISP.

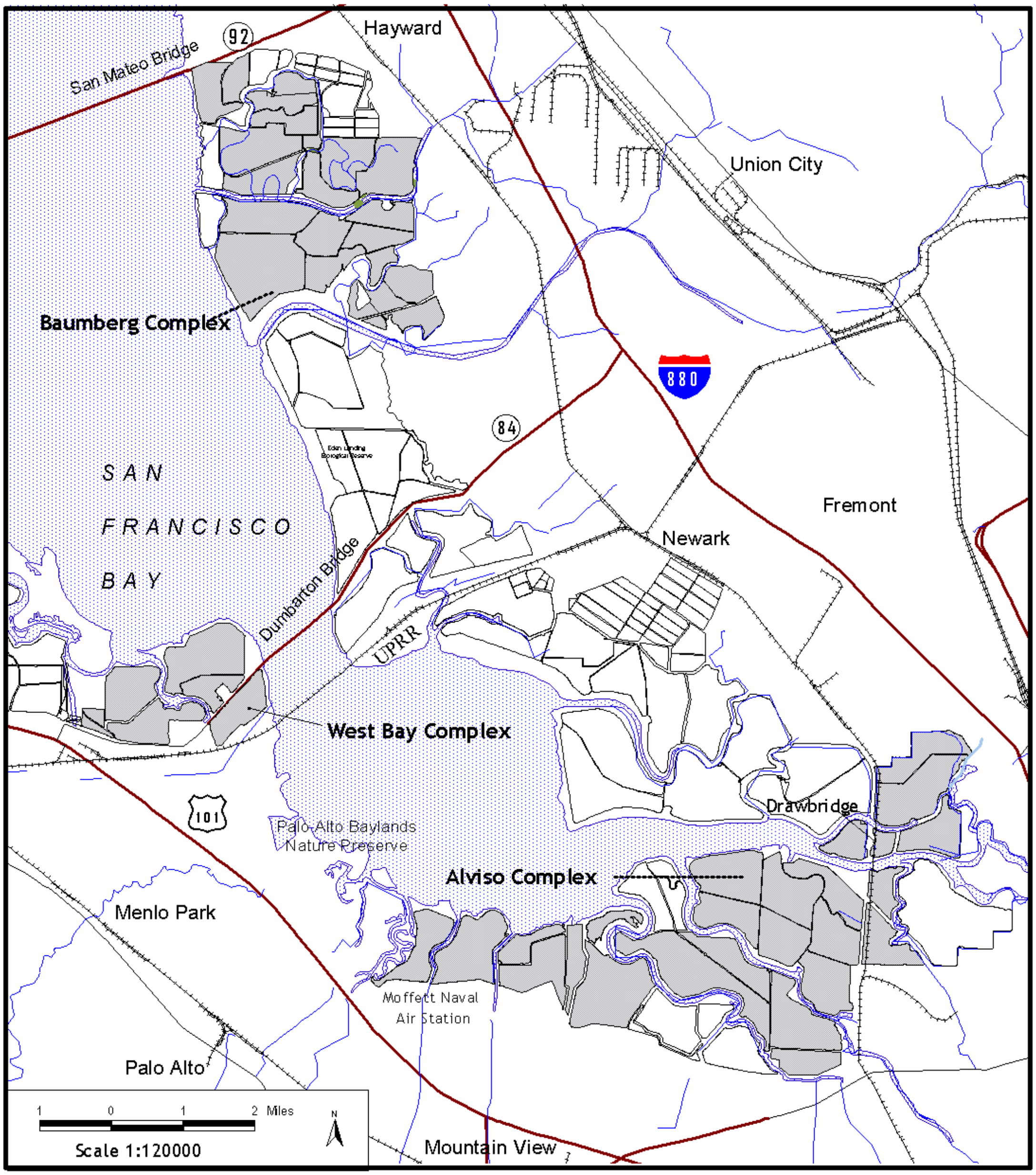


Figure 1-1
Map of Baumberg, Alviso, and West Bay Complexes

1.2.1 Baumberg Complex

The Baumberg ponds consists of a 5,500 acre complex of evaporator ponds (B1-B14 of Figure 1-2) in the East Bay west of Hayward and Union City in Alameda County. Since the complex contains only evaporators, brine historically has been pumped for final treatment to the Newark plant or to the Redwood City plant through a pipeline paralleling the Dumbarton Bridge. The approach to the San Mateo Bridge and the Eden Landing Ecological Reserve, formerly known as the "Baumberg Tract," form the northern boundary of the complex. The reserve was established in May 1996 to restore former salt ponds and crystallizers to tidal salt marsh and seasonal wetlands. Alameda Creek Flood Control Channel (also known as Coyote Hills Slough) and the Coyote Hills form the southern boundary.

Major drainages that discharge into the San Francisco Bay within the complex include Mount Eden Creek and Old Alameda Creek and Alameda Creek Flood Control Channel. Alameda Creek Flood Control Channel diverges from Old Alameda Creek in Union City to provide bypass capacity during large floods. Several hundred acres of extant tidal marsh front the San Francisco Bay, known as the Whale's Tail Marsh at the center of the complex. The marsh is located outboard of ponds 9, 8A, 2, and 1, where Mount Eden Creek discharges into the Bay. Prior to the acquisition, all ponds within this complex were under Cargill ownership and have now been transferred to the DFG.

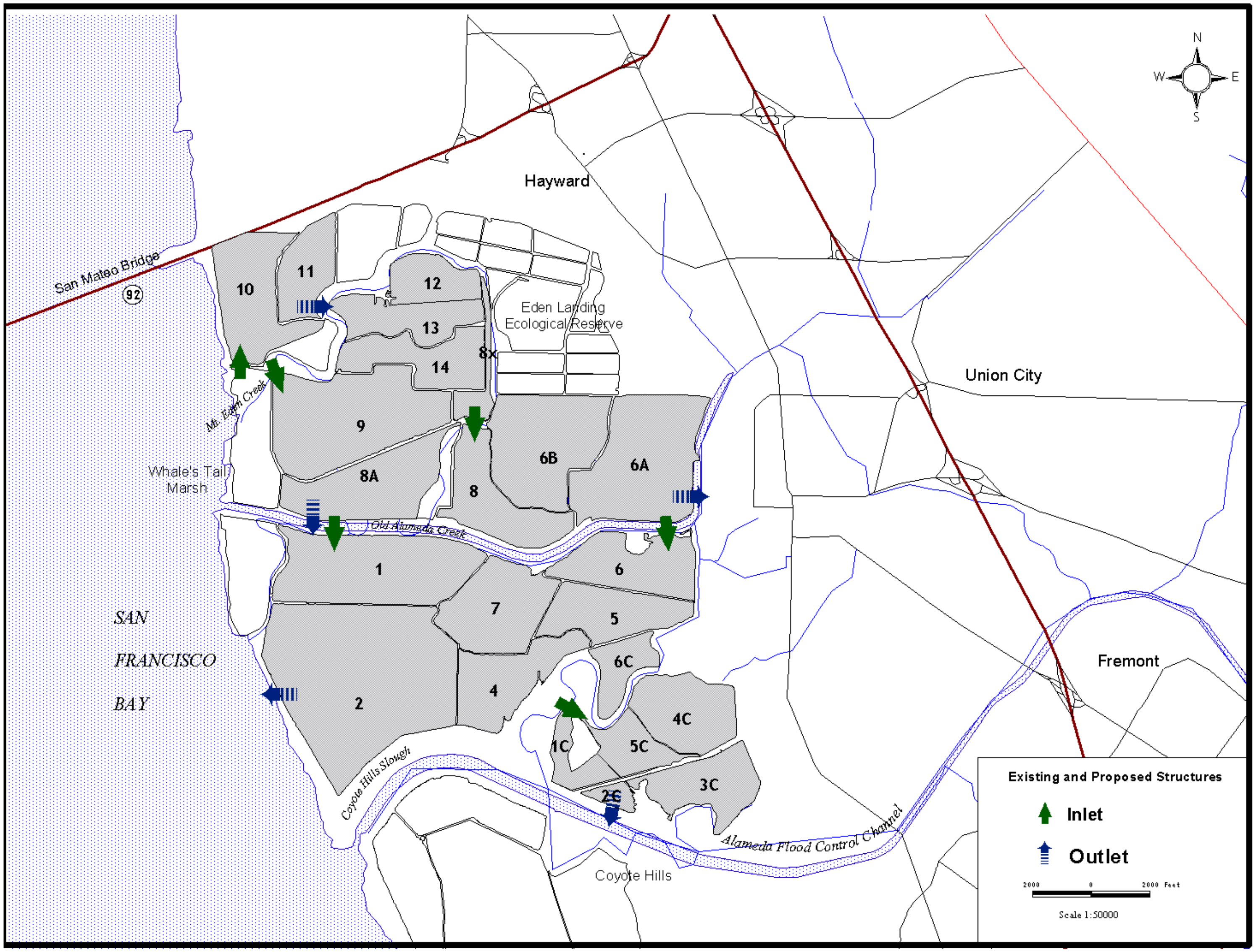


Figure 1-2
Map of Baumberg Complex

1.2.2 Alviso Complex, including Alviso Ponds

The Alviso complex is the largest complex in the South Bay, consisting of 8,000 acres of 25 ponds (A1-A23, B1 & 2 of Figure 1-3) at the Bay's southern extremity in Santa Clara and Alameda counties. Because the complex contains only evaporators, brine historically has been pumped northward to the Newark #2 site for crystallization and final processing. Ponds are located bayward of the cities of Fremont, San Jose, Sunnyvale and Mountain View. The complex area is flanked on the west by Palo Alto Baylands Nature Preserve and Charleston Slough, to the south by Moffet Naval Air Station, Sunnyvale Baylands Park and the east by Coyote Creek and Alviso and Fremont. Major drainages which discharge into San Francisco Bay within the complex area include Charleston Slough, Mountain View Slough, Stevens Creek, Guadalupe Slough, Alviso Slough (Guadalupe River), Artesian Slough, Mud Slough, and Coyote Creek. The Project does not include Ponds A18 and A4.

The USFWS acquired fee title to Ponds A1 to A8 (with the exception of Pond A4) and portions of A22 and A23. Cargill Salt is sold its reserved salt-making rights on Ponds A9 to A17, Ponds A19 to A21 and portions of Ponds A22 and A23. Pond A4 will be used by Santa Clara Valley Water District to restore wetlands to mitigate for losses resulting from construction of the Lower Guadalupe River Flood Protection Project. Cargill is negotiating with City of San Jose for the sale of pond A18 to the City.

The historic and abandoned town of Drawbridge, which still has standing hunting cabins and an active railroad line (UPRR), is located between ponds A20 and A21. Ponds 19, 20 and 21 are surrounded by Mud Slough to the east and Coyote Creek to the west and are collectively known as the “Island Ponds.” The bottom elevations of the Alviso ponds are generally lower than other complexes due to subsidence from historic groundwater withdrawals. Broad expanses of mudflats exposed at low tide are found at the confluence of Coyote and Alviso creeks, outboard of pond levees.

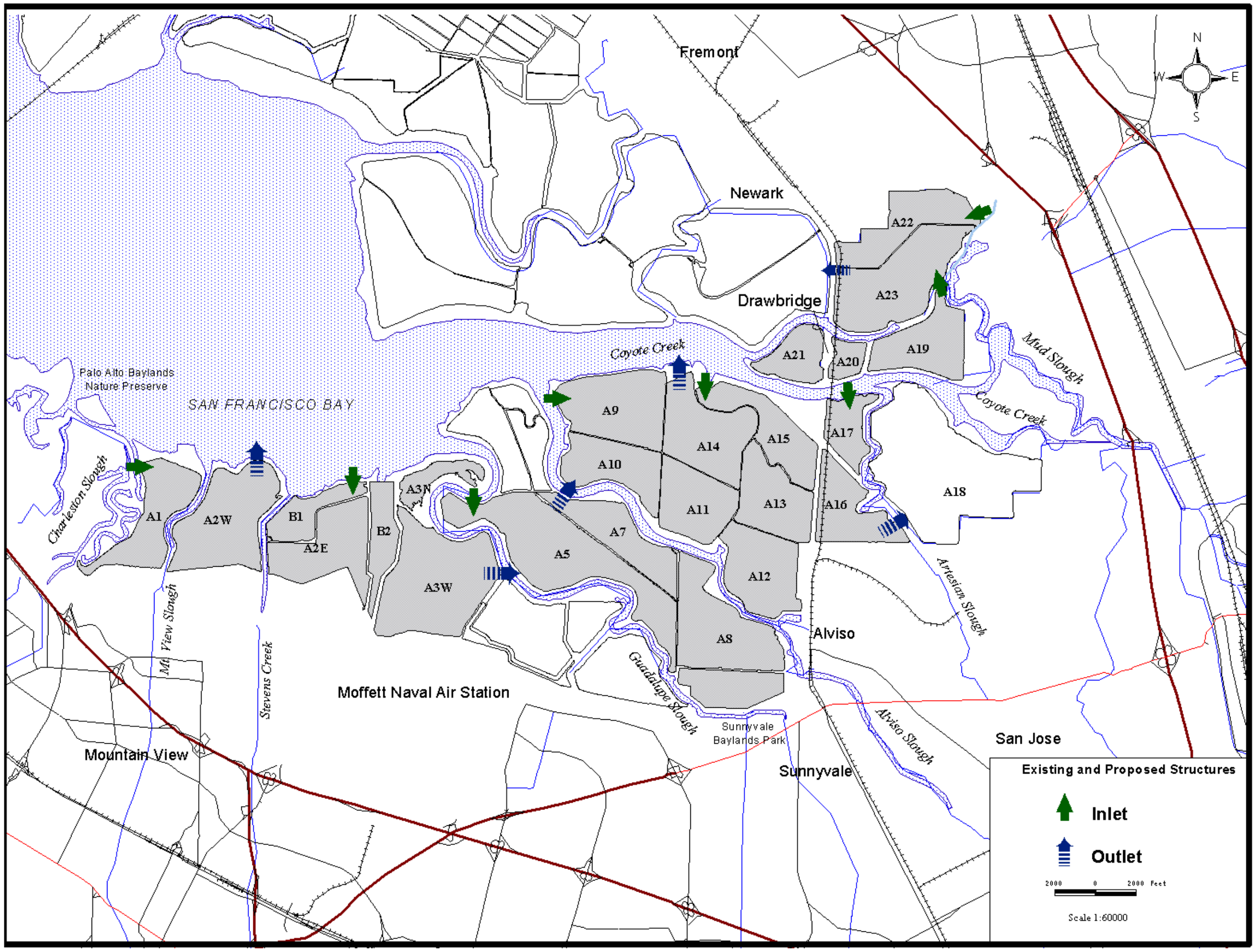


Figure 1-3
Map of Alviso Complex

1.2.3 West Bay Pond Complex

The West Bay Ponds consist of a 1,600 acre complex of 7 ponds (1-5, S5, & SF2 of Figure 1-4). The complex is located south of the Bay and the boundary between Menlo Park and Redwood City. The City of Menlo Park is located to the west, and the Dumbarton Bridge approach and the UPRR are located at its southern border. Ravenswood Slough discharges near the complex. Prior to the acquisition, Cargill owned all ponds in this complex with the exception of evaporator ponds 1 and 2 on which Cargill owned reserve salt-making rights. The USFWS acquired the West Bay ponds 3, 4, 5 and S5. Cargill is giving up salt making rights for ponds 1 and 2. Pond SF2 has not been acquired, but will be transferred later.

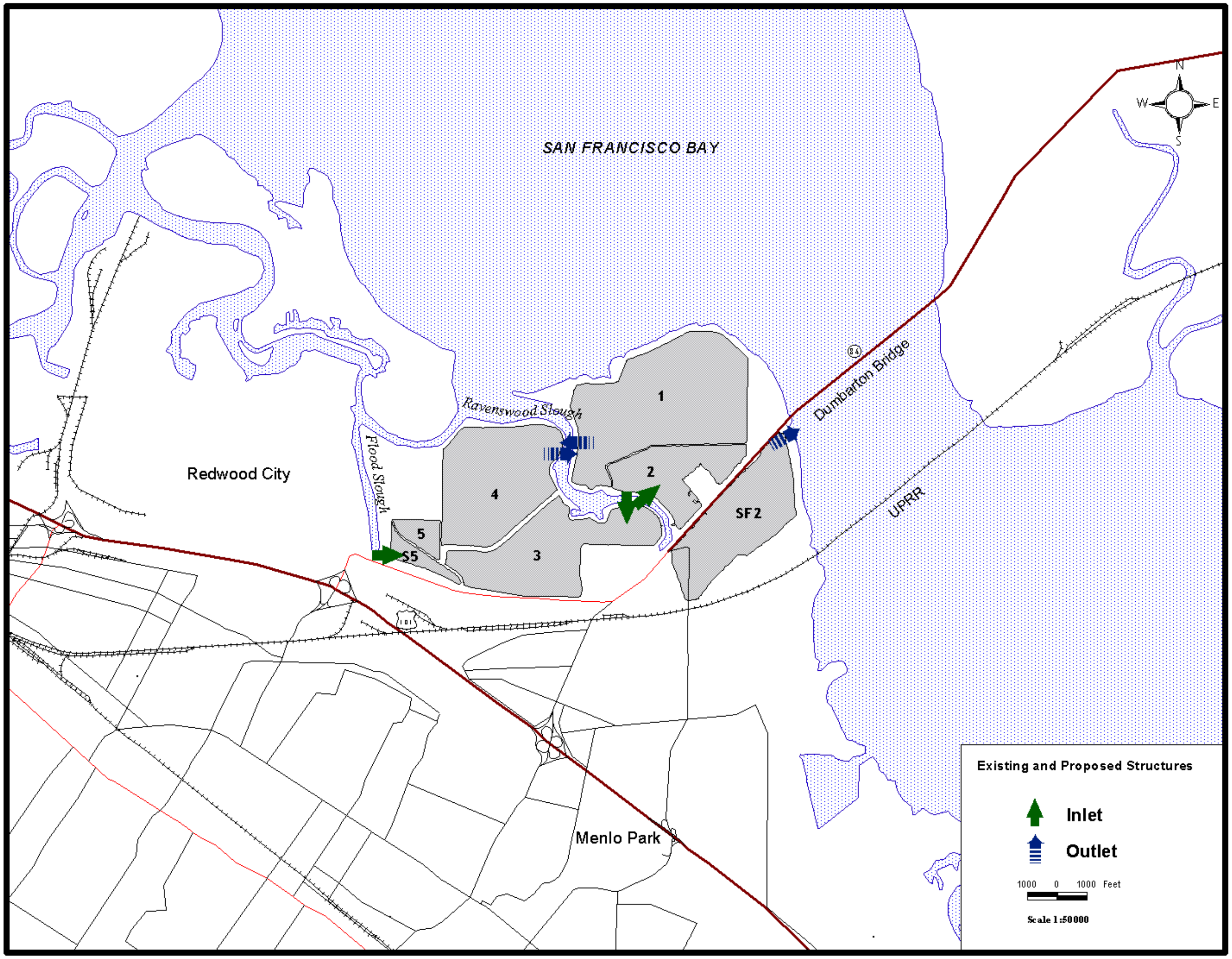


Figure 1-4
Map of West Bay Pond Complex

1.3 Site Background and History

The solar salt industry in San Francisco Bay began in the middle 1850s. The first operations were simple levees built around naturally occurring salt pans in Alameda County to increase their capacity. They were small family enterprises that used intensive hand labor for production and harvest. Nearly all of the salt produced in San Francisco Bay during this era was shipped to Nevada to be used for the processing of silver ore. By the late 1800s, an estimated 37 salt production facilities had been established throughout the South Bay. Most of these facilities were constructed by diking tidal marshes (BCDC, 1994, p. 19). The diked marshes were fitted with operator-controlled intake structures to capture seawater during high tides. The Baumberg ponds first came into production in the late 1800s. The Alviso ponds came into production in 1929.

By the early 1900s, the quality of the salt produced in San Francisco Bay had increased significantly, and the market expanded to include fine or "table" salt. In 1936, the Leslie Salt Company was created from the consolidation of 19 small operations. Following this consolidation, only Leslie and Oliver salt companies remained. Oliver, located at the foot of the Hayward-San Mateo Bridge, ceased to operate in the 1970s. In 1979, Cargill bought Leslie and is now is the only solar salt producer in San Francisco Bay (BCDC, 1994, p. 19).

Salt production involves a sequence of ponds through which seawater is progressively cycled to concentrate and ultimately precipitate salt. Salt production takes approximately five years from the time that the water enters the system from San Francisco Bay until the salt is harvested. The salt production process begins as high tide brings baywater into the initial or intake pond, the first in a series of ponds called evaporator or concentrator ponds. Evaporator ponds range in size from less than 100 acres to more than 850 acres.

The ponds are separated by earthen levees – some constructed more than a century ago – and are interconnected with siphons and gates. Through natural evaporation, water is drawn out, creating increasingly saline brine. As brine flows to the next evaporator pond, it becomes increasingly concentrated with salt. When fully saturated, the brine is pumped into the pickle ponds for storage before it is crystallized and harvested. For the most part, Cargill Salt uses gravity to transfer brines from one pond to the next by taking advantage of differences in hydraulic head. When siphons or gates are open, differences of less than a few inches in surface elevation or "hydraulic head" between two ponds will result in a net flow of brine from one pond to the next until the water surfaces are equal in elevation. The pickle pond solution is then pumped into crystallizer beds to undergo final evaporation, resulting in the precipitation of salt crystals.

After a layer of salt approximately 5 to 8 inches thick has formed on the bottom of the crystallizer ponds, the remaining solution, called bittern is pumped into the desalting pond where additional sodium chloride is removed and then to the bittern pond for storage. Bittern contains highly concentrated magnesium, potassium, bromine and sulfate. Salts are mechanically harvested from the crystallizer beds and transported to the wash house by truck and then by conveyer to the salt stack. In the final stage of production, the raw salt will be sent to the refinery at Newark for further processing, packaging and shipping to customers. The Newark plant produces about 650,000 tons of salt per year. All of the ponds included in the ISP are concentrator ponds. No crystallizer ponds were included in the land transfer.

About 200 miles of pond levees separate the individual ponds and isolate salt production facilities from the bay. Levees require periodic maintenance to prevent failure from erosion, subsidence and consolidation. Currently approximately 10 miles of levees are maintained each year. Levee maintenance consists of excavating mud from salt pond borrow ditches and placing it on levees using a floating dredge.

2.0 Environmental Setting

This section describes the existing environmental setting for the South Bay Salt Ponds. Beginning with an overview of biological resources and concluding with a discussion of physical characteristics of the habitat. Information has been summarized from various reports on the San Francisco Bay and the salt pond communities.

2.1 Biological Resources

2.1.1 Vegetation

There are significant floristic differences between the San Francisco Bay and other similar regions along the central coast of California. These differences include some vegetation types unique to the ecosystem: the dominance of Pacific cordgrass (*Spartina foliosa*), the presence of disjunct populations of the rare species California sea-blite (*Suaeda californica)* and the presence of local endemic species such as soft bird's beak (*Cordylanthus mollis ssp. mollis*) and Suisun thistle (*Cirsium hydrophilum var. hydrophilum*) (Olofson, et. al., 2000, p. 11).

To describe the tidal wetlands, three elevation saltwater zones have been used to classify tidal marshes: the "low marsh zone" occurs from the mean sea level to the mean high water; the "middle marsh zone" occurs from approximately the mean high water to the mean higher water; and the "high marsh zone" occurs near and above mean higher water up to several meters above the extreme high water line. The "high marsh zone" is also known colloquially as the "upper marsh transition" or "upper salt marsh zone" (Peinado, et. al, 1994).

The native Pacific cordgrass generally dominates the low marsh zone, along tidal creek banks and the edges of tidal mudflats. In middle marsh zone, which makes up an extensive portion of the San Francisco Bay, younger marshes are characterized by vegetation dominated by pickleweed (*Salicornia virginica*) with some areas containing saltgrass (*Distichlis spicata*), salt marsh dodder (*Cuscuta salina*), alkali heath (*Frankenia salina*) and spearscale or fat hen (*Atriplex triangularis*). The low marsh and middle marsh zones are increasingly being impacted by an Atlantic species of invasive Spartina (*Spartina alterniflora*) and several species of other non-native pickleweed. Other invasive species in the middle marsh include brass buttons (*Cotula coronopifolia*) and Mediterranean saltwort (*Salsola soda*).

The high marsh zone commonly includes natives such as gumplant *(Grindelia stricta*) (often dominant in the zone), salt marsh dodder, pickleweed, alkali heath, sea lavender (*Limonium californicum*) and spearscale. Common non-native species in the high marsh zone include perennial pepperweed (*Lepidium latifolium*), bassia (*Bassia hyssopifolia*), saltwort (*Salsola soda*), wild beet (*Beta vulgaris*), annual iceplant (*Mesembryanthemum nodiflorum*), iceplant (*Corpobrotus edulis*), Australian saltbush (*Atriplex semibaccata*), ripgut brome (*Bromus diandrus*), sicklegrass (*Parapholis incurva*) and rabbit's-foot grass (*Polypogon monspeliensis*) (Monroe, et. al., 1999, pp. 12-13).

Tidal mudflats are expanses of barren muds, below the low marsh zone that are uncovered during low tides. According to one account, prior to filling and diking, flats were ubiquitous and as wide as two miles. In the South Bay, each day as the tide went out, almost 50,000 acres of tidal flats emerged along margins of bays and larger tidal creeks and sloughs. (Olofson, et. al., 2000). Currently, the South Bay supports approximately 30,000 acres of tidal mudflat (San Francisco Bay Conservation and Development Commission, 1994, p. 21). In areas where salt ponds have been constructed, mudflats are located outboard of the salt pond levees. Mudflats are habitat to algae, diatoms and invertebrates and when exposed, provide the major food source for shorebirds. During inundation periods at twice daily high tides, mudflats are feeding areas for fish.

2.1.1.2 Vegetation within Salt Ponds

Most salt pond complexes in the South Bay were built on tidal marsh. Salt ponds and dredge locks were constructed using bay mud for the levees around ponds.

Active salt ponds support a distinctive group of halophilic (salt-loving) biota made up of microalgae, photosynthetic bacteria and invertebrates. Vascular plants only exist along the edges of the pond levees. With presence varying by salinity, the dominant organism in these hypersaline ponds is the single-celled green algae (*Dunaliella salina*), halobacteria and purple sulfur-reducing bacteria. Ponds, such as those serving as intake areas with salt concentrations closer to sea levels, contain marine algae, such as sea-lettuce (*Ulva*), *Enteromorpha ssp., Cladophora ssp*., and sometimes *Fusus ssp*. and *Codium ssp*. in firmer substrate. These areas also include marine diatoms, dinoflagellates and cryptomonads (Monroe, et. al., 1999, p. 45).

Colors in salt ponds range from pale green to deep coral pink and indicate the salinity of the ponds. In low- to mid-salinity ponds (50-110 parts per thousand [ppt]), green algae proliferate, lending the water a green cast. The typical salinity of sea water is 32 ppt. As the salinity increases, *Dunaliella* out-competes the other microorganisms in the pond, and the color shifts to an even lighter shade of green. In mid-to high-salinity ponds (200-250 ppt), high salt concentrations actually cause the *Dunaliella* to produce a red pigment. Brine shrimp in mid-salinity ponds contribute an orange cast to the water. Halophilic bacteria such as *Stichococcus* and purple sulfur-reducing bacteria also contribute red and reddish purple tints to high-salinity brine (Monroe, et. al., 1999, p. 45).

Field observations made at the Department's Eden Landing Ecological Reserve, where salt production had ceased in 1972, indicate vegetation cover is generally limited to ponds with salinity levels lower than 30 ppt. Vegetated areas had a mean salinity of 22 ppt compared to non-vegetated areas with mean salinity of 65 ppt. At the reserve, the lower salinity ponds had characteristics of a San Francisco Bay salt marsh, with transitional pickleweed and saltgrass. In these ponds, there was a gradual succession from pickleweed stands to mixed stands of pickleweed and ruderal/hydrophytic grassland associations. Higher salinity muds were colonized on a seasonal basis by annual pickleweed (*Salicornia europa*). A correlation was also observed between percent vegetative cover greater than 50 percent and salinity less than 50 ppt. (Resource Management International, Inc., 1999, p. 10).

Salt pond dredge lock interiors are ponds primarily containing open water and mudflat habitat. With sufficient sedimentation in the lock, ponds will support Pacific cordgrass or alkali bulrush *(Scirpus robustus)* at lower salinity levels. While smooth cordgrass can be an invader of mudflat areas between mean sea level and mean high water, smooth cordgrass is not common in dredge locks (Wetland Research Associates, 2000).

Levees around salt ponds and dredge locks support both native and weedy species. At mean tide level, Pacific cordgrass and alkali bulrush are common while at higher zones, pickleweed is present. Monotypic stands of perennial pickleweed can be found along the margins and toe of slopes of levees. Salt bush and fleshy jaumea (*Jaumea carnosa*) can also be found along with pickleweed. Upland areas above the extreme high tide zone support alkali heath, salt grass, perennial pepperweed, and coyote brush. Perennial pepperweed is a common dominant species on many levee crowns and disturbed sites and can form monotypic stands on recently disturbed sites, displacing native marsh vegetation. While it can establish through seed, it spreads primarily by subsurface rhizomes, which sprout and form new plants when broken by tilling or excavation (Wetland Research Associates, 2000).

2.1.1.3 Vegetation along Sloughs and Creeks

Tidal salt marsh occurs in more saline conditions, while tidal brackish marsh occurs under fresher conditions generally where tributary streams discharge freshwater into the Bay. As the streams approach the Bay, plant associations change with the progression of salinity levels from freshwater to brackish to tidal. Upper reaches of the creeks and sloughs support predominantly alkali bulrush and/or peppergrass. Lower reaches support single species stands, or mixed stands of pickleweed and cordgrass depending on water depth. Pacific cordgrass occurs primarily in areas of persistent high salinity, alkali bulrush occurs in brackish water conditions, and California tule *(Scirpus californicus)* in freshwater conditions. Their distribution and abundance are related to their tolerance to water salinity and other factors, including tidal regime, disturbance, substrate type, marsh age, erosion and accretion patterns.

In a comparative study from 1989 to 1999 of marsh plant associations along lower Coyote Creek and Alviso and Guadalupe sloughs, H.T. Harvey & Associates documented the conversion of 127 acres of salt marsh to less saline brackish and freshwater habitat types. Freshwater discharge from South Bay wastewater treatment facilities has contributed to this conversion where California tule has replaced both Pacific cordgrass and alkali bulrush. However, the authors noted some areas of habitat conversion were at locations outside the influence by treatment facility discharges, and therefore, causes of conversion could not be solely attributed to the wastewater facilities. They also documented sedimentation of open water habitats from tributary streams has created new salt marsh within the study area (Harvey, 2001).

Vegetation in and adjacent to streams and sloughs around the South Bay salt ponds were mapped by Jones & Stokes for San Francisco International Airport to assess the potential of complexes for habitat mitigation (Jones & Stokes, 2001). Dominant communities of some of the major creeks and sloughs in the Initial Plan area are tabulated below in Table 2.1:

Table 2.1
Acreage of Slough and Creek Habitats

	Acres of Habitat			
	Mudflat	Salt Marsh	Brackish/ Freshwater	Open Water
Alviso Slough	58	57	118	83
Coyote Creek	293	116	306	258
Guadalupe Slough	37	60	156	122
Mt. View Slough	9	30	x	8
Mud Slough	x	29	112	38
Ravenswood Slough	57	8	x	17

As shown in the Table 2.1, broad areas of mudflat are located at the confluence of Alviso Slough and Coyote Creek.

2.1.2 Wildlife

Salt ponds provide important habitat for wildlife, the most visible of which are the resident and migratory waterfowl and shorebirds. The birds use the ponds and adjacent upland levees for feeding, roosting and as a place to rest during high tides. Pond depth also plays a key role in attracting certain water birds. Small and medium sized shorebirds dominate when the pond depth is shallow. During the rainy periods of the winter months, waterfowl use the deeper ponds extensively.

The ponds support an abundant source of food that attract birds to salt ponds, such as brine shrimp, salt marsh boatman and brine fly. Growing up to 10 millimeters, brine shrimp *(Artemia franciscana)* provide a major food source attracting birds to the salt ponds. Brine shrimp thrive in salt ponds where salinity measures 80 to 190 ppt (8 to 19 percent), where there is plenty of algae to eat and few predators and competitors. The tiny, egg-like cysts of brine shrimp are also sold as "Sea Monkey eggs" to hobbyists. Brine shrimp are commercially harvested from many of the salt ponds to supply the aquarium fish industry.

2.1.2.1 Waterfowl

During the winter, the San Francisco Estuary provides habitat for more than 300,000 ducks and geese (Accurso, 1992). The estuary provides habitat for the largest winter populations of canvasback *(Aythya valisineria)* on the Pacific Flyway. Winter surveys of salt ponds in the 1980s recorded more than 100,000 ducks (Harvey, et. al. 1988). Between 1988-90, the lower salinity (20-63 ppt.) South Bay ponds of moderate size (50-175 ha) supported 21-27 percent of waterfowl, including 90 percent of northern shovelers *(Anas clypeata)* (Harvey, et. al., 1992).

Species known to breed in or around the South Bay salt ponds include Canada geese *(Branta canadensis),* mallard *(Anas platyrhynchos),* gadwall *(Anas strepera),* northern pintail *(Anas acuta),* northern shoveler, cinnamon teal *(Anas cyanoptera),* and ruddy duck *(Oxyurajamaicensis).* Two waterfowl species that occur in the Estuary have special conservation status. The Aleutian Canada goose *(Branta canadensis leucopareia)* is federally threatened, and Barrow's Goldeneye *(Bucephela islandica)* is listed as a California Species of Special Concern. Both species are uncommon in the South Bay.

Waterfowl populations in the San Francisco Bay and Sacramento-San Joaquin Delta were assessed in a series of surveys taken in midwinter in years 1988 through 1990. More than 700,000 waterfowl were observed in the Bay and Delta, and more than 300,000 of these individuals were observed in open Bay areas and salt ponds (Accurso, 1992). These surveys showed that salt evaporation ponds supported 30-41 percent of the waterfowl in the San Francisco Estuary (Accurso, 1992). The South Bay salt ponds supported up to 76,000 (or 27 percent) of the estuary's total waterfowl population. This area has provided the largest haven for ruddy ducks in the region (up to 67 percent of the population), and supported 17 percent of the canvasbacks, 50 percent of the bufflehead and up to 86 percent of dabbling ducks, including the majority of shovelers. Waterfowl were concentrated in lower salinity (20-63 ppt) ponds, with few birds present in ponds above 154 ppt. Most waterfowl used ponds of moderate size, from 5 to 175 ha. The open water areas of the South Bay supported 9 to 11 percent (or 36,000) of the waterfowl in the Estuary, and were important for scaup (18 percent) and scoter (16 percent) (Monroe, et. al., 1999, pp. 310-311).

2.1.2.2 Shorebirds

With their cylindrical bills of different length and curvature, some 31 species of shorebirds inhabit the San Francisco Bay. These include birds of a wide range of sizes – from the sparrow-sized least sandpiper *(Calidris minutilla)* to the duck-sized long-billed curlew *(Numenius americanus).* They feed primarily on invertebrates obtained on tidal flats, salt ponds, managed wetlands and other habitats. Most tidal flat specialists are found concentrated in the North and South Bays. San Francisco Bay supports very high numbers of shorebirds of most species during migration and winter compared with other wetlands along the Pacific Coast (Page, et. al., 1991).

A federally listed threatened species, the western snowy plover (*Charadrius alexandrinus nivosus)* makes extensive use of the South Bay salt evaporation ponds. In addition, the red knot *(Calidris canutus)* has been found foraging and roosting in the South Bay salt ponds. The western sandpiper is the most abundant shorebird in the estuary. The Wilson's phalarope *(Phalaropus tricolor)* and the red-necked phalarope *(Pbalaropus lobatus)* are also most dependent on the salt ponds for foraging habitat, during spring and fall migration, while the others, including black-necked stilt and American avocet *(Recurvirostra americans),* are resident and nest primarily in South Bay salt ponds (Monroe, et. al., 1999, pp. 311-312).

2.1.2.3 Other Bird Species

Other birds that inhabit the South Bay salt ponds include:

Eared grebes *(Podiceps nigricollis)* are found through the estuary, but can be seen using the medium to high salinity salt evaporator ponds for resting or forage. They prefer the habitat of the medium or medium-high salinity ponds from late August through April or early May, a period when bird counts may include up to several thousand birds per pond. These ponds show high concentrations of brine shrimp *(Artemia salina)* and/or water boatmen *(Hemiptera: Corixidae),* which are prime prey for these small grebes. The grebes may also eat brine-fly (Diptera: E*pbydra* sp.) larvae and pupae which spend most of the time below the 1/4-meter depth, or even adult brine flies on the water surface (Olofson, 2000, pp. 317-318). They are also known to breed in salt ponds, building floating nest platforms anchored to salt pond substrate or algal mats from March to June (San Francisco Bay Conservation and Development Commission, 1994, p. E1).

American white pelican *(Pelecanus erythrorhynchoss)* is a State Species of Special Concern. They feed in several lowest salinity salt evaporators and around the Bay from July through October in considerable numbers. A few have been recorded to be present through June. Even in their peak period, local surveys of only one set of low-saline ponds may often reveal no white pelicans, while a few days later (or even later the same day) scores or hundreds may be present.

Double-crested cormorant (*Phalacrocorax auritus*) is a State Species of Special Concern. They can be found in large numbers in low salinity ponds all year, but can be found in other salt evaporation ponds in considerable numbers in the fall (San Francisco Bay Conservation and Development Commission, 2000. p. 324). The numbers of double-crested cormorants using salt ponds either for foraging and daytime resting or for nesting on structures within the ponds is probably rather small compared to the total number in or near the deeper parts of the Bay. In more recent years, they have increasingly taken to nesting on the platforms or sometimes at junctions of legs and braces of power line towers, e.g., many such south of the western part of San Mateo Bridge (Monroe, et. al., 1999, p. 396).

Snowy egret (*Egretta thula*), a member of the heron family, commonly inhabit fresh, salt and brackish water wetlands. They prefer mudflats and tidal areas for feeding, but have been found feeding and resting in low salinity ponds when prey items such as small fish, frogs, crustaceans and large insects are in abundance (Olofson, 2000. p. 327). High numbers of breeding pairs nest at the heron colony on Mallard Slough located between the Alviso ponds A17 and A18 (San Francisco Bay Conservation and Development Commission, 1994, p. E7).

Black-crowned night heron is *(Nycticorax nycticorax*is) a common resident of saltwater and brackish marshes throughout the San Francisco Bay Area. They use the low-salinity, fish-bearing salt ponds for foraging and prefer places where water moves past their perch, such as gates or siphon-flows between ponds. Partly because they do much of their feeding at night, less is known about their foraging habits. The usually roost during the day in small to fairly large flocks in the non-breeding season, typically in trees or within marsh growth, , e.g., in the primarily pickleweed marsh south of the outermost part of Alvarado Channel (old Alameda Creek) (Olofson, 2000, p. 396). As with the snowy egret, high numbers of breeding pairs nest at the heron colony on Mallard Slough. (San Francisco Bay Conservation and Development Commission, 1994, p. E3)

Northern harrier *(Circus cyaneus)* is a common year around resident raptor in the South Bay marshes. They are a State Species of Concern due to declines in both breeding and winter populations. They nest in salt marshes (upper portions, that are not flooded by tides in April or May), as well as in or near freshwater marshes or grassy flats inland. They feed on small mammals, birds, frogs, crustaceans, insects and occasionally on fish (BCDC, 1994, p. E34). In the non-breeding season, and in the breeding period within proximity to nest sites, they frequently forage over various marshes, fields, roadsides, dikes, and also those salt ponds that have numerous birds (Monroe, et. al., 1999, p. 397).

California brown pelican (*Pelecanus occidentalis*)is a state and federally listed endangered species. Weighing up to 17 kilograms, they are one of the largest piscivorous birds of coastal and estuarine waters of North America. They breed in colonies in southern coastal waters, and migrate north to winter in central California north to the Columbia River. Several hundred occur within the San Francisco Bay from July through November, where they can be found foraging in deeper waters including salt ponds, lagoons and mouths of the larger creeks. They feed on schooling fish, and favor deeper waters, which allow them to dive into water to catch fish (Monroe, et. al., 1999, p. 322). Modest size flocks have been observed to forage at times in the low-salinity South Bay ponds (Monroe, et. al., 1999, p. 394).

California clapper rail *(Rallas longirostris obsoletus)* is a state and federally listed endangered species that depends almost entirely on low intertidal salt marsh for foraging, retreat from danger, and for nesting marsh (San Francisco Bay Conservation and Development Commission, 1994, P. E10). (See discussion in Section 2.1.2.5 Special Status Species.)

California gull (*Larus californicus*) has been drawn to the San Francisco Bay by the availability of remote nesting locations in former salt ponds and abundant food sources in adjacent municipal landfills. In 1980, 12 nests were encountered in a salt pond near Alviso in Santa Clara County. Beginning in 1984, California gulls began breeding at other sites within the South Bay. In 1993, California gulls nested on an attached levee and a series of small dredge spoil islands near Mountain View in Santa Clara. Currently, approximately 10,000 California gulls nest in South Bay (Olofson, 2000, p. 350). California gulls are abundant in the San Francisco Bay in the winter, although no reliable estimates of wintering numbers exist (Harvey, et. al., 1992).

Caspian terns *(Sterna caspia)* are found around ocean shores, lakes, estuaries, and salt ponds, where they aerially search, hover and dive for small fish (Cogswell, 1977; Zeiner. et. al., 1990). They have nested on dikes or on barren islands within salt evaporators in the South Bay since at least 1922 in a colony that had 287 active nests in 1931 (DeGroot, 1931). Anderson (1970) discovered a thriving colony of Caspian terns on the southern part of the curving dike between ponds east of Albrae Slough (Monroe, et. al., 1999, pp. 398-399). Unfortunately, this colony has since been abandoned due to predators

Forster's tern *(Sterna forsteri)* is found mostly from May through September in or near salt pond habitats, when it is nesting or when the fledged young are still under intensive care by the adults. A few are present through the winter in favored locations around the Bay, but are seldom seen then on salt ponds. Nesting takes place at numerous locations, on pond levees and on small islands within the low- to medium-low salinity ponds (where fish are abundant, and where the newly fledged young may first try their own plunge-dives). Some colonies, however, are on islands within medium- high to high-salinity ponds, at the Newark #1 complex, just south of the eastern approach to Dumbarton Bridge and Newark Slough. There are no fish in those ponds, and foraging is entirely in the slough or the open Bay. However, where these are in salt ponds subject to spring or early summer draw-down by the pond operators, their success is jeopardized by the relatively easier access to the sites by predators (Monroe, et. al., 1999, p. 399).

California least tern *(Sterna antillarium browm)* is a federally and state listed endangered species. It prefers open, sandy beaches in the vicinity of lagoons or estuaries (San Francisco Bay Conservation and Development Commission, 1994, p. E31). (See discussion in Section 2.1.2.5 Special Status Species.)

2.1.2.4 Fish

Some 15 species of fish can be found in the South Bay salt ponds. Of these, six reproduce in the ponds. Entering through the intakes to the Bay, these are primarily salt tolerant fishes, including topsmelt (*Atherinops affinis*), longjaw mudsucker (*Gillichthys mirabilis*) and staghorn sculpin (*Leptocottus armatus*). These species all tolerate salinities over 60 ppt (Lonzarich, 1989; WRA, 1994; Carpelan, 1957). According to Lonzarich (1989), fish species diversity decreases with salinity, but abundance does not always decrease with salinity. Fish are more abundant in ponds with low salinity. In the low salinity ponds, macro-invertebrates provide as essential resource for fish populations.

None of the fish resident in the South Bay ponds have special conservation status, but many of the small fish living in the salt ponds provide food for special status birds, such as American white pelicans, California brown pelicans, California gulls, and California least terns. While salt pond have a limited capacity to support fish, the sloughs, tidal marshes, mud flats, and estuaries provide important areas for foraging and escape cover for fish.

According to Moyle and Chechi (1982), fish that inhabit the estuaries can be classified into five types. *Nondependent marine* fishes are found near oceanic mouths of the estuaries and do not depend on the estuary for their life cycles. *Dependent marine* species need the estuary to complete at least one of their life stages. This could include spawning, rearing young or feeding as juveniles or adults. *True estuarine* species complete their entire life cycles in the estuary. The Delta smelt (*Hypomesus transpacificus*) is the only true estuarine species. *Diadromous* species use the estuary as a migratory corridor to travel to their spawning grounds. The most common of these species grow to maturity in the ocean and spawn in freshwater (anadromous). In the South Bay, these include the Chinook salmon, steelhead trout and striped bass (*Morone saxatilis*). Freshwater species are those that complete their entire life cycles in the upper reaches of tidal influenced estuary areas. An example of the freshwater species is the Sacramento splittail (*Pogonichthys macrolepidotus*). See section 2.1.2.8 Special Status Fish Species for a discussion of sensitive fish species within the project area.

In the estuary, the presence of fish species – the abundance and distribution – depends on physical and chemical factors such as temperature, salinity and oxygen levels. Most fish species use the estuary on a seasonal basis. In the estuaries adjacent to the South Bay salt ponds, the fluctuating salinity is a factor in presence of fishes using the waters.

In general, the South Bay normally would reflect more of a marine environment, because the reduced flows of fresh water result in relatively high salinity levels. However, outflows from water treatment plants have increased freshwater flows to the system. Several small freshwater creeks provide a source of food for fishes. These include San Leandro Creek, Alameda Creek, Coyote Creek, Upper Penitencia Creek, Alviso Slough, Stevens Creek, San Francisquito Creek, and San Lorenzo Creek.

2.1.2.5 Special Status Species

Special-status species are plants and animals that are legally protected under the state and federal endangered species acts or other regulations, and species that are considered rare by the scientific community. Special-status species are defined as follows:

- Plants and animals that are listed or proposed for listing as rare, threatened, or endangered under the California Endangered Species Act (Fish and Game Code 1992 Sections 2050 et seq.; 14 CCR Sections 670.1 et seq.) and/or the Federal Endangered Species Act (50 CFR 17.12 for plants; 50 CFR 17.11 for animals; various notices in the Federal Register [FR] for proposed species).

- Plants and animals that are Candidates (Category 1) for possible future listing as threatened or endangered under the Federal Endangered Species Act (50 CFR 17.12 for plants; 61 FR 7591, Feb. 28, 1996, for animals).

- Plants and animals that meet the definition of rare or endangered species under CEQA Guidelines Section 15380, which includes species not found on State or Federal Endangered Species lists.

- Plants occurring on Lists 1A, 1B, 2, 3, and 4 of the California Native Plant Society's (CNPS) Inventory of Rare and Endangered Vascular Plants of California (Skinner and Pavlik, 1994). The Department recognizes that Lists 1A, 1B, and 2 of the CNPS inventory contain plants that, in the majority of cases, would qualify for state listing, and the Department requests their inclusion in EIRs as necessary.

- Animals that are designated as "Species of Special Concern" by the Department (1994).
- Animal species that are "fully protected" in California Fish and Game Code, Sections 3511, 4700, 5050 and 5515).
- Animals that are designated as federal "Species of Concern" by the Service.

See Table 2.1.2.5 for a list of known occurrences of special status species.

Table 2.1.2.5
Known Occurrence (X) or Potential Habitat (H) for Federally-listed Species, Seabird Colony, Shorebird Roost Site, Heron Rookery and Harbor Seal Haul-out.
(Adapted from San Francisco Bay Conservation and Development Commission, 1994.)

Complex	System	Pond (Incl. Adjacent Marsh habitat)	Clapper Rail*	Salt Marsh Harvest Mouse*	California Least Tern	Western Snowy Plover	Seabird Colony	Shorebird roost site	Heron Rookery*	Harbor Seal Haul Out*
Alviso										
	A2W	A1	X	H	X		X			
		A2W	X		X					
	A3W	B1	X		X					
		A2E	X	X	X	X				
		B2	H	H	X	X	X			
		A3W	H	H				X		
		A3N	H	H	X			X		
	A7	A5				X	X	X		
		A7				X	X	X		
		A8				X	X	X		
	A14	A9	H	H	X			X		
		A10	H	H						
		A11			X		X			
		A14	X	X	X		X	X		
		A12		X						
		A13								
		A15	X	X						
	A16	A16		X			X		X	
		A17	X	X			X		X	X
	A18	A18	X	X			H		X	
	A23	A22	H	H		X				
		A23	H			X				

* Present only in bay or slough areas adjacent to salt ponds.

Table 2.1.2.5
Known Occurrence (X) or Potential Habitat (H) for Federally-listed Species, Seabird Colony, Shorebird Roost Site, Heron Rookery and Harbor Seal Haul-out.
(Continued)

Complex	System	Pond (Incl. Adjacent Marsh habitat)	Clapper Rail*	Salt Marsh Harvest Mouse*	California Least Tern	Western Snowy Plover	Seabird Colony	Shorebird roost site	Heron Rookery*	Harbor Seal Haul Out*
	Island ponds	A19	X	H						
		A20	X	H						X
		A21	H	H						X
	Lock A7		X	X						
	Lock A10/11			H						
	Lock A15		X	X	X					
	Lock A16								X	
	Lock A17		H	X			X			H
	Lock A18								X	
	Lock A19		H	H						
	Lock A20S		H	H						
	Lock A20N		H	H						
	Lock A21		H	H						
	Lock A23		H	H						
	Lock B1		X	H	X					
	Lock A1		X	H	X		X			

* Present only in bay or slough areas adjacent to salt ponds.

Table 2.1.2.5
Known Occurrence (X) or Potential Habitat (H) for Federally-listed Species, Seabird Colony, Shorebird Roost Site, Heron Rookery and Harbor Seal Haul-out.
(Continued)

Complex	System	Pond (Incl. Adjacent Marsh habitat)	Clapper Rail*	Salt Marsh Harvest Mouse*	California Least Tern	Western Snowy Plover	Seabird Colony	Shorebird roost site	Heron Rookery*	Harbor Seal Haul Out*
Baumberg	B2	1	X	H	X		X	X		
		2	X	H	X	X	H	X		
		7		H	X		H			
		4		X	X		X			
	B2C	6		H						
		5		H						
		6C		H	H					
		4C	No data	No data	No data	No data	No data	No data	No data	
		3C	No data	No data	No data	No data	No data	No data	No data	
		5C	No data	No data	No data	No data	No data	No data	No data	
		1C	No data	No data	No data	No data	No data	No data	No data	
	B6A	6A		H		X				
		6B		H		X	X			
	B8A	8A	X	X		H	X	X		
		8X								
		9	X	H	X	X				
		14		X	X	X	X	X		
		13		X	X	X		X		
		12		X	X	X		X		
		10		H	X	X	X			
	B10 or B11	11		H	X	X	X			
	Lock 2		X	X						
	Lock 8A		X	X						
	Lock 10			H						

Table 2.1.2.5
Known Occurrence (X) or Potential Habitat (H) for Federally-listed Species, Seabird Colony, Shorebird Roost Site, Heron Rookery and Harbor Seal Haul-out.
(Concluded)

Complex	System	Pond (Incl. Adjacent Marsh habitat)	Clapper Rail*	Salt Marsh Harvest Mouse*	California Least Tern	Western Snowy Plover	Seabird Colony	Shorebird roost site	Heron Rookery*	Harbor Seal Haul Out*
Redwood City	West Bay	1	H	H			X	X		
		2								
		3			X	X				
		4		H		X				
		5				X				
		S5								
		SF2	H	H				X		
		3			X	X				
		4		H		X				

* Present only in bay or slough areas adjacent to salt ponds.

Six listed species, the salt marsh harvest mouse (*Reithrodontomys raviventris*), the California clapper rail (*Rallus longitostris obsoletus*), western snowy plover (*Charadrius alexandrinus nivosus*), California least tern (*Sterna albifrons browni*), California black rail (*Laterallus jamaicensis coturniculus*), and the American Peregrine Falcon (*Falco peregrinus anatum*) use the South Bay salt ponds.

2.1.2.6 Listed Species

2.1.2.6.1 Salt Marsh Harvest Mouse (Reithrodontomys raviventris raviventris)

The salt marsh harvest mouse is endemic to the tidal marshes of the San Francisco Bay region. This species is similar to the western harvest mouse, *Reithrodotomys megalotis.* These two species are genetically isolated by a different chromosome number (Shellhammer, 1987). However, the salt marsh harvest mouse evolved from western harvest mouse some 8,000 to 25,000 years ago with the creation of the marshes in the San Francisco Bay (Service, 1984). Its historic range included the extensive marsh system bordering San Francisco, San Pablo, and Suisun Bays.

The salt marsh harvest mouse was listed as an endangered species by the U.S. Department of the Interior in 1970, and by the Department in 1971 (Shellhammer, 1982). The Service (1984) recovery plan identifies five reasons for decline of this species: habitat loss, fragmentation of remaining habitat, back filling of habitat, land subsidence, and vegetation changes. Approximately 80 percent of the historic tidal marshes in the Bay have been destroyed or modified (SFEP, 1991). Prior to mid nineteenth century, 734 square kilometers of tidal marsh existed around the Bay. Today only 152 square kilometers exist, much is fragmented or modified (Service, 1984).

Two sub-species of the salt marsh harvest mouse are recognized: *Reithrodontomys raviventris raviventris*, which is the southern sub-species, and *Reithrodontomys raviventris halicoetes*, the northern sub-species. There are a few populations of the southern sub-species in Marin and Point Richmond, but most of this sub-species occurs in southern half of South San Francisco Bay (SSFB). In the South Bay, the range of the species extends from San Leandro around to the Belmont area. The northern sub-species is found in the marshes along the San Pablo and Suisun Bays and along northern Contra Costa County coast. The pelage coloration on the belly of the southern sub-species is typically cinnamon, from which the scientific name of this species was derived; *Reithrodontomys raviventris* means "grooved-toothed mouse with a red belly."

The salt marsh harvest mouse exhibits physiological and behavioral adaptations, which allows this species to survive in the salt marsh and associated grassland (Shellhammer, 1987). These unique adaptations include excellent swimming abilities, tolerance of high salinities in its food and drink, and docile behavior. The *R. r. raviventris* can undergo daily torpidity. These adaptations appear to provide this species with a competitive advantage in the marsh environment (Fisler, 1965).

The habitat area commonly associated with this species is the mid-to-upper tidal salt marsh. It lives in dense pickleweed stands. Shellhammer (1982) concluded that pickleweed is "the preferred habitat of the salt marsh harvest mouse wherever it occurs, and that the taller, denser stands of pickleweed support the most salt marsh harvest mice." In the 1984 Service recovery plan, the best habitat for the salt marsh harvest mouse is characterized as having 100 percent cover, a cover depth of 30 to 50 cm at summer maximum, greater than 60 percent cover by pickleweed, and habitat complexity which includes saltbush, alkali heath or other halophytes. Wondolleck, et. al. (1976) and others have also found that in the South Bay, the species was most commonly associated with lush pickleweed, mixed with salt bush and alkali heath. In a study conducted by Johnson and Shellhammer (1988), it was determined that salt marsh harvest mice prefer pickleweed to grassland. They found that 86.8 percent of the salt marsh harvest mice captures occurred in pickleweed. Salt marsh harvest mice did intermittently utilize and move through grassland areas, however, they primarily remained in pickleweed areas. Use of grasslands increased in the springtime, when grasses sprout and provide increased cover in grassland (Johnson and Shellhammer, 1988). The use of adjoining grasslands as refugia was also documented by Fisler (1965) during the highest winter tides or flooding events.

In diked marsh systems, the use of grasslands may reflect the lower nutritional value of the pickleweed, which does not receive the daily nutrient input from tidal waters. The salt marsh harvest mouse may be required to seek a wider dietary selection in the grasslands, especially at the onset of the breeding season (Johnson and Shellhammer, 1988).

The salt marsh harvest mouse is not an obligate species to pickleweed habitat. It can also occur in other marsh vegetation communities composed of species such as fat hen and bulrush (*Scirpus robustus*), providing the vegetation offers appropriate multilayered structure. Zetterquist (1978) found that the salt marsh harvest mouse will use marginal habitats. At some of the sites examined by Zetterquist, the vegetation patterns were altered by diked conditions, and the dense cover was not always present. In other trapping studies of *R. r. halicoetes* conducted by the Department (Botti, et. al. 1986; WESCO, 1979 and 1982), salt marsh harvest mice were captured in habitats containing no little or no pickleweed. The vegetation composition of these areas typically consisted of fat hen, saltgrass, baltic rush (*Juncus baliticus*), alkali heath, and other grass species, and in one location on Suisun Bay, a dense stand of tule (*Scirpus spp*.). Although pickleweed is the preferred habitat for this species, they may be found in sub-optimal habitats depending on the season, environmental condition, and proximity of these areas to more typical habitat. Many locations of potential habitat and occupied habitat for the salt marsh harvest mice were found on vegetated levees dominated by pickleweed near each of pond complexes.

2.1.2.6.2 California Clapper Rail (*Rallus longirostris obsoletus*)

The California clapper rail, a federally and state-listed endangered species, has historically occurred in tidal salt marsh and brackish marshes along the northern and central California coastlines. However, the existing population of clapper rails is almost entirely limited to the San Francisco Bay area. As with the salt marsh harvest mouse, the overriding cause for listing the California clapper rail is the loss and fragmentation of suitable tidal marsh habitat, particularly the loss of large blocks (greater than 40 acre in size) of contiguous tidal marsh (Evans and Collins, 1992). The California clapper rail is almost exclusively associated with broad tidal marshes, which support an intricate network of slough channels, which provide feeding areas as well as escape corridors from predators (Harvey, 1988). Clapper rails feed on invertebrate species located in mud flats, creek banks, marsh vegetation, and shorelines at low tide. Clapper rails generally occupy habitat composed of mid and high marsh and typically nest in associated vegetation including cordgrass, pickleweed and gumplant.

California clapper rail populations have dropped alarmingly in the last two decades. The first intensive surveys were conducted in the early 1970's and by Gill (1979) who estimated the total population to be between 4,200 and 6,000 birds at that time. By the early 1990s, the population had declined to about 300 to 500 rails (Takekawa, 1992). This latter decline has been attributed to introduction and spread of the red fox (*Vulpes fulva*) in the marshes surrounding the Bay. Following implementation of red fox and other predator control programs on the San Francisco Bay National Wildlife Refuge and adjacent baylands, rail populations have rebounded to an estimated, wide population in the range of 1040 to 1,264 rails, of which an estimated 650 to 700 are located in the South Bay (C. Wilcox, personal communication, 2001).

Clapper rails were observed in the northern half of the Whale's Tail Marsh outboard of Baumberg pond 9 during census counts in 1984 and 1985 (Cole/Mills Associates, et. al., 1987). Non-protocol level surveys conducted in 1998 documented clapper rails in the same area, but none were identified at the mouth of Mt. Eden Slough or along the lower slough. The mudflats and tidal marsh outboard of Cargill's Newark #1 and Newark #2 complexes and the southern portion of Greco Island (across Ravenswood Slough from the Redwood City plant site) are noted as high use areas for the rail. High use areas within the Initial Stewardship Plan area include marsh zones along Charleston Slough, Mt. View Slough, and Stevens Creek surrounding Alviso ponds A1 and A2W (Wetland Research Associates, Inc., 2000).

2.1.2.6.3 Western Snowy Plover (*Charadrius alexandrinus nivosus*)

The western snowy plover is federally-listed as a threatened species. Studies indicate that San Francisco Bay is one of the most important breeding areas for snowy plovers along the Pacific Coast (Page et. al. 1991). Snowy plovers also winter in the Bay, making it one of the most important wintering locations for plovers along the Pacific Coast (Page, et. al., 1986).

Snowy plovers have nested at the salt ponds of South Bay since the late 1800s. Snowy plovers prefer barren, non-vegetated areas such as levee tops close to brine flies and other food sources in the salt ponds. They feed in shallow water or forage at the edge of water in ponds. Pond levees at the upper Baumberg area (ponds 2, 8, 9-11), the Newark #1 complex, Alviso Ponds A-22 and A-23 and the West Bay Ponds provide important nesting habitat (San Francisco Bay Conservation and Development Commission, 1994, p. E24).

2.1.2.6.4 California Least Tern (*Sterna albifrons browni*)

The California least tern, a federally and state-listed endangered species, requires coastal habitats during its breeding season. Nesting colonies are typically located in close proximity to shallow waters populated by small fish, the main source of food for the least tern, and consist of flat areas characterized by little or no vegetation, and loose, sandy, or mixed substrate. As a result of human disturbance of traditional breeding areas, the least tern, like the western snowy plover, has shifted its breeding activities to include nesting on salt pond dikes, bare flats, and sand fills.

Observations suggest that intake ponds can provide important habitat for fledgling least terns that need to develop the requisite foraging and feeding skills critical to successful migration (Feeney, 1988). High use areas for the tern include the Baumberg complex, the Alviso ponds A9-15 between Coyote Creek and Alviso Slough, pond A1 between Charleston and Mt. View Sloughs, and ponds B1, 2 and A2E east of Stevens Creek.

2.1.2.6.5 California Black Rail (*Laterallus jamaicensis coturniculus*)

The California black rail, a state-listed threatened species, inhabits freshwater, saltwater and brackish marshes. The California black rail is an elusive bird that is rarely observed. As a result, there is little reliable data concerning historical and present population densities. Black rails appear to prefer higher elevation tidal marshes comprised of dense vegetation. Although black rails have not been observed on or around the project site, suitable wintering and potential breeding habitat exists along the upper margins of the marsh at the lower end of Mt. Eden Creek (Thomas Reid Associates, 1989).

2.1.2.6.6 American Peregrine Falcon (*Falco peregrinus anatum*)

The American peregrine falcon a federal and state listed endangered species. Peregrine falcons typically nest in cliffs with good visibility; however, they can occasionally be found nesting in transmission towers, bridges, and tall buildings. The area that an individual falcon requires for foraging purposes can be quite large depending upon the availability of an adequate food supply. The peregrine falcon's principal sources of food are passerine birds, waterfowl and shorebirds. Peregrine falcons are regularly observed foraging on the Eden Landing Ecological Reserve, adjacent to the Baumberg complex, and this use is assumed to include resident and migratory populations.

2.1.2.7 Non-listed Species

2.1.2.7.1 Salt Marsh Wandering Shrew (*Sorex vagrans halicoetes*)

The salt marsh wandering shrew is classified as a "Mammalian Species of Special Concern" within the state of California. Salt marsh wandering shrew habitat consists of middle elevation tidal salt marsh composed of dense stands of pickleweed, jaumea and occasional saltgrass. Shrews are typically found in areas of marsh that provide dense cover, an abundance of invertebrate animals for food, suitable nesting and resting sites, and fairly continuous ground moisture (WESCO, 1986). Although no shrews have been captured on the site, one shrew was observed during trapping activities conducted by WESCO during 1985 (Thomas Reid Associates, 1989).

2.1.2.8 Special Status Fish Species

The steelhead trout and chinook salmon have been reported to occur in the areas designated to receive the circulation of saline waters from the South Bay salt ponds and serve as intake points. In order to assess the potential for impacts to this species associated with such circulations, the distribution, abundance, and timing of these species in the vicinity of the proposed circulation locations was estimated based on a review of the scientific literature as well as interviews with staff of the interested resource agencies.

The results of this evaluation are summarized in Table 2.1.2.8.1 (which lists where these salmonids are found) and Table 2.1.2.8.2 (which describes when these species would likely be present in the circulation areas). More thorough review of the distribution, abundance, and life history characteristics of steelhead trout and chinook salmon are provided below.

2.1.2.8.1 Steelhead Trout

This species (*Oncorhynchus myskiss*) is native in tributaries to SSFB, using these streams for spawning and rearing of juveniles. Small runs of steelhead trout have been identified in Coyote Creek and Guadalupe River (which discharges into Alviso Slough), with each run numbering approximately 100 to 300 individuals annually (J. Abel, Santa Clara Water District; G. Stern, NMFS, personal communication, 2002). The steelhead do not spawn in those sections of Coyote Creek and Alviso Slough which could potentially receive any saline water circulated from the South Bay salt ponds, but would use these sections as migration corridors to upstream spawning and rearing sites. According to M. Roper (DFG, personal communication, 2001), there is an effort to develop a steelhead run in Alameda Creek. Apparently, this species has historically used Alameda Creek, but is unable to do so now due to man-made physical blockages, which prevent upstream migration. Efforts are being made to physically transport upstream migrating adult steelhead around these blockages so they can reach their spawning grounds.

Due to their life history strategy, steelhead trout are only present in the potential circulation areas during limited portions of the year. Generally, adult steelheads migrate from the ocean to the South Bay tributaries from late December through early April, with the greatest activity in January through March. It would be during this time frame that adult steelhead would be migrating through the potential circulation areas. Spawning occurs in the upper reaches of the Coyote Creek and Alviso Slough/Guadalupe River watersheds, well upstream of any elevated salinity plume. After either one or two years of rearing, juvenile steelheads migrate from their upstream rearing areas to the ocean. Most of this downstream migration of juveniles occurs between February and May, with the peak between March and April. It is during this period that the juveniles would pass through the potential circulation areas.

The steelheads remain in the ocean for 2 to 4 years until they reach reproductive condition. At that point, they migrate into the estuary and return to their South Bay tributaries to spawn. Once spawning has occurred, the adults swim downstream and return to the ocean. Each winter, for several successive years, these adults repeat their upstream migration to spawn and, subsequent, downstream migration to the ocean waters.

2.1.2.8.2 Chinook Salmon

This species (*Oncorhynchus tshawytscha*) is not native in tributaries to SSFB. Chinook salmon were first observed in South Bay tributaries in the early 1980s and, based on genetic analyses, are probably from Sacramento River hatchery stock (G. Stern, NMFS, personal communication, 2000). Small runs of this species have been identified in Coyote Creek and Guadalupe River (which discharges into Alviso Slough), with each run numbering approximately 100 to 200 individuals annually (J. Abel, Santa Clara Water District, personal communication, 2000). The Chinook salmon do not spawn in those sections of Coyote Creek and Alviso Slough which could potentially receive any saline water circulated from the South Bay salt ponds, but would use these sections as migration corridors to upstream spawning and rearing sites.

Due to their life history strategy, Chinook salmon are only present in the potential circulation areas during limited portions of the year. Generally, these fall-run adult Chinook salmon migrate from the ocean to the South Bay tributaries from late September through November. It would be during this time frame that adult fish would be migrating through the potential circulation areas. Spawning occurs in November through December in the upper reaches of the Coyote Creek and Alviso Slough/Guadalupe River watersheds, well upstream of any elevated salinity plume. After a few months of rearing, juvenile Chinook salmon generally migrate from their upstream rearing areas to the ocean. Most of this downstream migration occurs between mid-March and early May. However, during big winter storm events, these juvenile salmon could be carried downstream as early as January or February. It is during this period that the juveniles would pass through the potential circulation areas.

The Chinook salmon remain in the ocean for two to four years until they reach reproductive condition. At that point, they complete their life cycle by migrating into the estuary and returning to their South Bay tributaries to spawn. Unlike steelhead trout, the Chinook salmon adults spawn only once and die after their first and only upstream migration.

Table 2.1.2.8.1
The Presence of Salmonid Species in each of the Potential Circulation Sites.

Circulation Location	Species of Interest Present	Description of Presence in Potential Areas of Circulation
Coyote Creek		
	Steelhead Trout	Uses area as a migration corridor to upstream spawning areas
	Chinook Salmon	Uses area as a migration corridor to upstream spawning areas
Alviso Slough		
	Steelhead Trout	Uses area as a migration corridor to upstream spawning areas
	Chinook Salmon	Uses area as a migration corridor to upstream spawning areas
Alameda Creek		
	Steelhead Trout	Only with human intervention, uses area as a migration corridor to upstream spawning
Guadalupe Slough		Neither salmonid species reported to use area
Alameda Flood Cont. Channel		Neither salmonid species reported to use area

Table 2.1.2.8.2
Temporal Patterns in the Abundance of Salmonid Species at South Bay Circulation Sites.

Species of Interest	Presence During Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Steelhead Trout												
Upstream Migrating Adults												
Downstream Migrating Juveniles												
Chinook Salmon												
Upstream Migrating Adults												
Downstream Migrating Juveniles												

2.2 Soils and Geology

U.S. Department of Agriculture (USDA) soil surveys classified the soil on the project site as either Reyes clay or Pescadero clay (USDA, 1975). The salt ponds are composed almost entirely of Reyes clay. The USDA describes Reyes clay as a "very deep, very poorly-drained soil that formed on alluvium that derived from mixed sources.” Bay muds and related alluvial deposits on the project site, including silt and clay deposits, may have been altered by so many years of salt production. Soil salinities in most of the ponds are elevated above "natural " conditions, with surface salinities ranging from 30 to 150 ppt. Levees throughout the site consist of a mixture of bay mud and urban fill material (e.g. soil, rock, gravel, concrete) that vary greatly in depth and drainage capacity.

Fault lines surround the project sites. The San Andreas fault runs parallel to the West Bay Complex and the Hayward and Calaveras faults run parallel to the eastern border of the Baumberg Complex. The US Army Corps of Engineers (USACE) addressed the salt pond levee stability during seismic events in a 1988 paper titled *San Francisco Bay Shoreline Study*. In this paper the USACE concluded that Cargill's levees were "particularly susceptible to rapid settlement due to liquefaction or lateral spreading of their underlying soils.” However, the same report notes that "there is no known historic record of shoreline levee failure in the study area due to earthquakes,” and even the intense seismic activity associated with the Loma Prieta Earthquake only resulted in minor cracking and settling of the salt pond levees.

The areas surrounding the Alviso Complex have subsided significantly since the levees were first constructed. Consequently, the levees now provide flood protection for the subsided surrounding land. Land subsidence in the southern San Francisco Bay can be attributed to the over drafting of aquifers during the first half of the twentieth century. Some areas have subsided as much as 13 feet between 1912 and 1969 (USACE, 1988).

2.3 Sediment Quality

The following is a presentation and discussion of the findings of the chemical characteristics of contaminants associated with sediments in the pond complexes.

The Cargill ponds were constructed for salt making purposes starting in the early 1900s by building levees around existing marshes, mudflats, and open water areas. Some of the Alviso ponds (A1 through A7) were constructed in the late 1940s. The sediments in this area have historically been subject to significant sources of contamination from historical mining activities (especially for mercury) in the Coast Range and Guadalupe River watershed. These mining activities resulted in the mobilization of large amounts of mercury-rich sediment into these downstream, wetland areas. Since diking the areas into ponds for salt-making operations, the source of contaminant input into these areas has generally been restricted to what comes in with the intake water, including some suspended sediment. Some contamination may also originate from the large wastewater treatment plant located upstream from the salt ponds and from urban runoff from the heavily populated and industrialized watershed. Ponds A5, A7 and A8 are not fully isolated during rare flooding events in the Guadalupe River, and can receive suspended sediment in floodwaters. In Cargill's recorded history two events where over topping occurred were noted in pond A-8. Suspended sediment in the ponds can then be transferred between ponds by an array of weirs and culverts. Consequently, sediment in the ponds would be expected to have similar characteristics to ambient conditions in the vicinity of each pond system, including elevated concentrations of some inorganics (e.g mercury).

Available sediment data from the ponds throughout the systems generally support this premise. The concentrations of contaminants in the ponds taken as a whole are similar to San Francisco Bay ambient concentrations. In the Alviso ponds, near the Guadalupe River/Alviso Slough the concentrations of some inorganics (notably arsenic, mercury, and selenium) are elevated over some reported San Francisco Bay ambient concentrations, but are within the range of ambient concentrations found within the South Bay and associated watersheds, including the Guadalupe River (See Table B-1 in Appendix B)

Sediment samples for inorganics were collected from 19 of the 57 ponds that are included in the ISP. These ponds are generally representative of all the ponds addressed by the ISP because they reflect the range of water depths and salinities present throughout the ISP ponds. Sampled ponds ranged in average water depth between 0.7 feet and 4.1 feet; average salinities in sampled ponds range between 15 and 110 parts per thousand. By comparison, the range of average water depths for all ISP ponds is zero to 4.1 feet, and the range of average salinities in these ponds is 11 to 150 and up to 200 ppt on the Island Ponds. Most of the available data are from the Alviso ponds. The Alviso ponds are located near the mouths of Alviso Slough and Guadalupe Slough, and Coyote Creek. This area is more directly affected by contaminants associated with historic mercury mining in the Guadalupe River drainage, municipal and industrial wastewater discharge, and the outflow of contaminants from an urban watershed. The weighting of the data toward the ponds with the higher concentrations is environmentally conservative.

Samples for organic chemicals (i.e., petroleum-based chemicals, including PAHs, PCBs and pesticides) were collected at several sites. They were either not detected in pond sediments, or were detected at very low concentrations similar to ambient concentrations found in the cleanest parts of the Bay. Therefore, the organic contaminant data are not discussed here (See Table A-1 in Appendix A).

2.3.1 Evaluation of ISP Pond Sediments

2.3.1.1 Alviso Complex

Sediment data collected by USFWS from selected ISP ponds are shown in Table 2.3.2.1-1. A data set taken by Hydroscience from selected ISP ponds is shown in Table 2.3.2.1-2. In general, concentrations of inorganics were detected in Alviso Complex sediments at levels similar to San Francisco Bay ambient concentrations. Arsenic, selenium, and mercury were detected in some ponds at concentrations elevated above Bay ambient concentrations, but within the concentration ranges observed within the Guadalupe River watershed. The trend of the data from other non-ISP salt ponds or collected in previous studies presented in the Appendices is inclined to support this conclusion.

Table 2.3.2.1-1

Alviso Pond System Inorganic Sediments
Data Source: Fish and Wildlife Service

Units = ug/g dry weight

Pond No.	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Zinc
Pond A1	7.1	<0.20	115	46	29	0.3	89	<0.6	110
Pond A1	4.7	<0.20	133	50	30	0.34	100	<0.6	130
Pond A1	7.0	0.50	130	50	28	0.3	100	<0.6	120
Pond B1	16.0	0.50	136	44	34	0.59	110	<0.6	120
Pond B1	19.0	1.00	149	48	37	0.57	110	<0.6	140
Pond B1	10.0	1.00	136	48	37	0.53	120	0.7	130
Pond A5	15.0	1.50	87	29	34	0.76	94	0.7	89
Pond A5	17.0	1.50	84	29	32	0.34	95	0.5	93
Pond A5	11.0	1.50	77	26	38	0.20	74	0.5	81
Pond A9	8.9	<0.20	134	37	19	0.30	96	<0.6	87
Pond A9	7.0	0.99	115	46	31	0.53	110	<0.6	110
Pond A9	9.0	0.50	127	39	34	0.69	110	0.6	110
Pond A10	12.0	<0.20	138	44	27	1.20	120	0.7	100
Pond A10	8.8	0.50	129	45	30	0.79	110	2.1	120
Pond A10	6.9	1.00	113	44	29	0.82	110	<0.6	110
Pond A16	11.0	0.99	102	44	57	0.71	100	0.8	150
Pond A16	11.0	0.99	69	36	40	0.38	73	0.5	110
Pond A16	12.0	0.99	101	41	47	0.56	110	0.6	140
Maximum	19.00	1.50	149.00	50.00	57.00	1.20	120.00	2.10	150.00
Minimum	4.70	<0.20	69.00	26.00	19.00	0.20	73.00	0.50	81.00
Arithmetic Mean	10.74	0.77	115.28	41.44	34.06	0.55	101.72	0.77	113.89
Median	10.50	0.99	121.00	44.00	33.00	0.55	105.00	0.56	110.00
n	18	18	18	18	18	18	18	18	18

Table 2.3.2.1-2

Alviso Ponds Inorganic Sediments (Alviso Complex)
Data Source: Hydroscience

Units = mg/kg dry weight

Method No.	EPA 6020	EPA 6020	EPA 6020	EPA 6020	EPA 6020	EPA 7471	EPA 6020	EPA 6020	EPA 6020	EPA 6020
Pond No.	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Lead**	**Mercury**	**Nickel**	**Selenium**	**Silver**	**Zinc**
A2W-A-S	5.85	ND	87.40	34.20	19	0.295	82.5	1.17	ND	74.2
A3W-A-S	17.5	ND	100.0	32.3	24.2	0.541	94.7	1.08	ND	77.9
A5-A-S	9.4	ND	85	35.8	33.5	1.92	83.7	0.713	0.252	94
A9-A-S	11.3	0.356	109	49.1	39	0.682	101	1.16	0.464	121
A15-A-S	11.8	0.329	88.7	40.2	48.3	0.791	81.3	0.829	0.82	103
A16-A-S	9.11	0.35	70.6	32.7	31	0.712	77.9	0.834	0.346	68.9
A17-A-S	10.2	ND	82.8	34.9	32.7	1.28	107	1.03	ND	92.9
Bay-A-S	14.5	ND	85.3	113.0	32.7	0.514	79.3	0.916	0.385	95.7

Maximum	17.50	0.35600	109.00	113.00	48.30	1.92	107.00	1.17	0.82	121.00
Minimum	5.85	0.32900	70.60	32.30	19.00	0.30	77.90	0.71	0.25	68.90
Mean	11.21	0.34500	88.60	46.53	32.55	0.84	88.43	0.97	0.45	90.95
Median	10.75	0.35000	86.35	35.35	32.70	0.70	83.10	0.97	0.39	93.45
n	8	3	8	8	8	8	8	8	5	8

Chromium, copper, lead, nickel, silver and zinc were detected in the Alviso Complex at relatively low concentrations. Mean concentrations of these chemicals were approximately half San Francisco Bay ambient concentrations. Maximum detected concentrations of these chemicals were only about 20% to 30% higher than San Francisco Bay ambient values. The distribution of these concentrations is heavily weighted toward the low end of their respective concentration ranges. This distribution combined with the fact that maximum concentrations are not highly elevated over Bay values (which are 85th percentiles) indicates that concentrations of these chemicals in the Alviso Complex are very similar to Bay ambient conditions.

The Island Pond system within the Alviso Complex was treated differently than the other sub-systems because the pond levees might be breached. Two composite samples are available for each of the three Island Ponds (A19, A20, and A21). One composite sample per pond represented surface sediments and one sample represents sediments at depth. Each composite sample was a compilation of the the three grab samples from around each pond. See Table 2.3.2.1-3. Mean concentrations of detected inorganics were well below San Francisco Bay ambient conditions. Maximum concentrations were also below ambient concentrations for all inorganics except mercury and selenium. The maximum detected concentrations for mercury and selenium were similar to ambient concentrations. The data indicate that the Island Pond sediments are similar to San Francisco Bay ambient concentrations and are unlikely to pose a risk to water quality or wildlife.

Table 2.3.2.1-3

Island Pond System Inorganic Sediments
Data Source: Hydroscience

Units = ug/g dry weight

Method No.	EPA 6020	EPA 6020	EPA 6020	EPA 6020	EPA 6020	EPA 7471	EPA 6020	EPA 6020	EPA 6020	EPA 6020
Pond No.	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Lead**	**Mercury**	**Nickel**	**Selenium**	**Silver**	**Zinc**
A21 S*	4.34	<0.17	32.9	12.6	9.83	0.08	40.1	0.88	<0.17	31.1
A21 D*	9.91	<0.17	73.7	29	14.2	0.31	84.8	0.44	<.17	60.5
A20 S*	7.56	<0.21	59.9	25.4	13	0.23	74	0.52	<0.21	49.2
A20 D*	7.28	<0.19	48.7	23.1	12.7	0.48	65.3	0.36	<0.19	44.4
A19 D*	12.2	<0.25	100	39.1	22.1	0.3	125	0.84	<0.25	77.8
A19 S*	4.67	<0.17	54.3	19.7	9.02	0.046	63.7	0.45	<0.17	37.9
Maximum	12.20	<0.25	100.00	39.10	22.10	0.48	125.00	0.88	<0.25	77.80
Minimum	4.34	<0.17	32.90	12.60	9.02	0.05	40.10	0.36	<0.17	31.10
Arithmetic Mean	7.66	<0.1933	61.58	24.82	13.48	0.24	75.48	0.58	<0.1933	50.15
Median	7.42	<0.3733	57.10	24.25	12.85	0.27	69.65	0.49	<0.3733	46.80
n	6	6	6	6	6	6	6	6	6	6

S*-Surface sample (0-6 Inches) D* -at depth sample (6-12 inches)

2.3.1.1.1 Alviso Complex Hydrologic Changes

An understanding of water depths in the ponds is an important component of assessing the potential for the mobility and exposure of sediment-associated contaminants, and how the ISP may affect risks to wildlife and aquatic resources. For example, very shallow water depths or sediment exposure to air can result in oxidation of sulfides and organic matter that are known to bind inorganic contaminants very strongly. If the pH of the system stays near neutral (a characteristic that can easily be monitored), the release of heavy metals (e.g., mercury) from sulfides and organic matter can be immobilized through their adsorption by clays and iron hydroxides in the sediment and water column. However, should the pH drop into the acid range (e.g., below pH 6), heavy metal adsorption by those solid phases would be depressed and additional heavy metals could be released from the sediment. Under these conditions, mercury could be made more available for methylation reactions to the toxic methyl mercury. For arsenic and selenium, pH affects are different as these chemicals are typically adsorbed by solid phases more strongly at acid pH than alkaline pH. The potential for methylation of mercury could be increased under drying and wetting cycles where previously bound mercury was made available during a drying cycle and then methylated upon a wetting cycle. In general, shallower and changing water depths that produce some aeration of the surface sediment can create opportunities for wildlife exposure to contaminants in those sediments due to the wetting and drying cycles.

Hydrologic modeling has been conducted by Shaaf and Wheeler to predict water elevations under the ISP and compare those elevations to existing conditions. On average, water elevations in the ponds with elevated concentrations of inorganics in sediment (A2W, A3W, A5, A9, A10, A15, A16, and A17) will be within about one foot of existing average elevations. Water in these ponds will be one to three feet deep on average throughout the year. Actual water depths within the individual ponds and pond systems will depend on the management operations.

In summary, since water depths in most of the ponds will be 1 to 2 feet on average, most of these ponds currently have and will continue to have high potential for use by a wide range of foraging shorebirds and waterfowl. Since some drawdown may occur at the extreme low end of the water regime, there is some potential for oxidation and increased mobilization of inorganics, including increased availability of mercury for potential methylation in drying/wetting cycles. In comparison with existing conditions, ponds A2W, A3W and A5 will be deeper on average, and ponds A9, A10, A15, A16, and A17 will be 0.5 to 2.5 feet shallower on average. The actual pond depths will depend on management operations in the future. ISP management will be diligent during the low end of the water regime to avoid drying cycles.

To the extent that periodically lower water levels increase the frequency of wetting/drying cycles in these ponds, the potential for oxidation of sediment and mercury methylation may be increased. However, the ponds are currently subject to a greater degree of variation in water depths than will occur under the ISP (about 1 to 2 feet in variation). The current frequency and duration of wetting/drying cycles is unknown. The greater variability in water levels under existing conditions may counteract the higher average water levels that currently prevail. Therefore, the existing frequency and duration of drawdown may be similar to or greater than that expected under the ISP. A description of hydrologic changes in each pond is presented below.

Water in pond A2W will be about 0.4 feet deeper on average than the existing average depth. The average water depth will be about 1.9 feet in summer and 2.2 feet in winter. Modeling results indicate that water depths will vary by about 0.5 feet, so even the lowest water levels would be about 1.5 feet above the pond bottom

Water in pond A3W will be about 0.2 feet deeper on average than the existing average depth. The average water depth will be about 1.8 feet in summer and 2.1 feet in winter. Modeling results indicate that water depths will vary by about 0.5 feet, so even the lowest water levels would be about 1.5 feet above the pond bottom.

Pond A5 will be about 0.4 feet deeper on average than existing conditions. The average water depths will be about one foot in summer and about 1.2 feet in winter. Modeling results indicate that water depths will vary by about 0.5 feet, so water depths could at times be within about 0.75 feet of the pond bottom. Existing operations have drown down pond A5 to average depths as low as 0.1 feet. Due to the slope of the pond bottom this has exposed up to half of the pond bottom.

Pond A9 will be about 2.5 feet shallower on average than existing conditions. Average water depths will be about 2.2 feet in summer and 1.7 feet in winter. Modeling results indicate that water levels will vary by about 1.5 feet, so water levels could at times be within one foot of the pond bottom.

Pond A10 will be about one foot shallower than existing conditions. Average water depths will be 2.5 feet in summer and 2.2 feet in winter. Modeling results indicate that water levels will vary by about 0.5 feet, so water levels could at times be within a 1.5 feet of the pond bottom.

Pond A15 will be operated as a batch pond to store and release water for controlling salinity in nearby ponds. In batch ponds, large volumes of water may be transferred from pond to pond during relatively short periods of time Therefore, water elevations can vary significantly and rapidly depending on management operations. The proposed operations would not result in more drying of sediment within this pond than under present conditions.

Pond A16 will be about 0.5 feet shallower than existing conditions. Average water depths will be 1.7 feet in summer and 1.6 feet in winter. Modeling results indicate that water levels will vary by about 0.5 feet, so water levels could at times be just over a foot higher than the pond bottom.

Pond A17 will be about 0.5 feet shallower than existing conditions. Average water depths will be 1.15 feet in summer and 1.05 feet in winter. Modeling results indicate that water levels will vary by about 0.5 feet, so water levels could at times be within a few inches of the pond bottom.

The Island Ponds will likely be breached and allowed to return to full tidal action. This management decision will be made based on the results of the CEQA/NEPA review. If the ponds are restored to full tidal action, available hydrologic modeling indicates that they would be inundated on the higher high tides but would be above water at other times. Based on this inundation frequency, the Island Ponds would be expected to become high intertidal marsh habitat. If restoration is delayed much beyond the time management responsibility transfers to FWS, the ponds would become seasonal; dry in summer and wet in winter until restoration begins.

2.3.1.1.2 Alviso Complex Management and Monitoring:

The ISP is an interim effort whose modifications of hydrology and wildlife use are likely to be minimal. Interim operations may offer opportunities to minimize existing levels of contaminant exposure. In general, the ponds will be managed with the goal of maintaining at least one foot of water. Opportunities for management of water levels once the ISP is implemented include adjustments to water control structures, for example adding or removing weir boards. Adjustments to water regimes to minimize contaminant exposure to birds must be weighed against potential impacts, including possible entrainment of salmonids if water inflow is increased during the migration season. Monitoring will be conducted during the initial stewardship period (most intensively in the first year) to ensure that water quality objectives in the RWQCB permit are met. Some preliminary recommendations for management and monitoring for the ISP ponds are described below. Management and monitoring activities will be developed and evaluated through the CEQA/NEPA and permitting processes.

To the extent possible within the limits of ISP infrastructure, and provided that adjustments to water regimes do not result in secondary impacts, the water regimes in the ponds with elevated concentrations of mercury and selenium (A2W A3W, A5, A9, A10, A15, A16, and A17) should be managed to minimize the potential for mobilization of inorganics, mercury methylation, and wildlife exposure. Possible strategies to accomplish this include maintaining water depths to minimize shorebird and waterfowl exposure, and reducing variation in water levels to avoid drying out and potentially mobilizing contaminants. The ponds will be adaptively managed; any adjustments would be made based on the results of monitoring.

Future water quality monitoring should be conducted in these areas to detect any mobilization of inorganics into the water column. In some areas, further sediment sampling would be advisable to better characterize sediment quality. Monitoring for methylmercury will be conducted as described in EIR/EIS or other pertinent documents. Additional analyses for other metals would be conducted in conjunction with that monitoring, possibly including sampling of fish tissue, bird eggs, and invertebrates in the ponds. Sampling of tissue in offsite locations to provide a comparison with ambient conditions would be advisable. Ponds that will be seasonal and have no available data (A3N, A12, and A13) should be characterized if they are seasonal. Sampling of pond A8 for selenium is advisable given the past presence of snowy plovers in that area. The presence of selenium concentrations over 1 mg/kg in nearby ponds (e.g., A3W and A9) indicates that sampling with appropriate detection limits is advisable.

Available data indicate that inorganics are present in the Island Pond System sediments at low concentrations that are unlikely to cause adverse effects on water quality or wildlife. Therefore, no special management considerations appear necessary. Additional data needs may become clear during future design and impact assessment. Possible data needs could include further sampling at depth in the areas near breaches where deeper tidal channels are most likely to form.

2.3.1.2 Baumberg Complex

Available sediment data in the Baumberg Complex consist of four samples representing three of the 23 ponds in the Baumberg system. These are shown in Table 2.3.1.2. The ponds for which data are available are generally representative of the range of water depths and salinities that characterize the Baumberg Complex. In the sampled ponds, average existing water depths range from 0.67 to 1.34 feet, and average salinities range from 26 to 156 parts per thousand. In comparison, average existing water depths for all the Baumberg Complex range from zero to 2.7 feet; average salinities range from 26 to 156 ppt. In general, lower concentrations of contaminants are expected in the Baumberg Complex based on their greater distance from known sources such as the Guadalupe River drainage.

Table 2.3.1.2

Baumberg Complex Inorganic Sediments
Data Source: Hydroscience

Units = mg/kg dry weight

Method No.	EPA 6020	EPA 6020	EPA 6020	EPA 6020	EPA 6020	EPA 7471	EPA 6020	EPA 6020	EPA 6020	EPA 6020
Pond No.	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Lead**	**Mercury**	**Nickel**	**Selenium**	**Silver**	**Zinc**
10-B-S	6.05	0.217	65.80	27.60	23.2	0.241	61.9	0.757	0.193	73.2
8A-B-S	1.01	ND	12.9	5.9	6.52	0.0736	13.5	0.868	ND	14
2C-B-S	11.6	ND	88.30	41.20	27.4	0.233	110	0.825	ND	86.5
2C-B-S (DUP)	6.8	ND	57.80	24.00	35.2	0.191	64.2	0.594	ND	64.9
Bay-B-S	5.41	ND	71.0	22.5	9.46	0.137	69.5	0.678	ND	58.1
Maximum	11.600	0.217	88.300	41.20	35.20	0.2410	110.00	0.8680	0.193	86.50
Minimum	1.010	0.217	12.900	5.89	6.52	0.0736	13.50	0.5940	0.193	14.00
Arithmetic Mean	6.174	0.217	59.160	24.24	20.36	0.1751	63.82	0.7444	0.193	59.34
Median	6.050	0.217	65.800	24.00	23.20	0.1910	64.20	0.7570	0.193	64.90
n	5	1	5	5	5	5	5	5	1	5

With the exception of selenium, which was detected at slightly above ambient concentration, inorganics were detected in the Baumberg Complex at concentrations below San Francisco Bay ambient concentrations. Mean and maximum detected concentrations of arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc were below ambient values and wetland cover criteria. Mean concentrations of arsenic, cadmium, chromium, copper, lead, silver, and zinc were below ER-Ls. Maximum concentrations of silver and zinc were also below ER-Ls.

2.3.1.2.1 Baumberg Complex Hydrologic Changes

The Baumberg Complex and their pond bottom sediments are currently at relatively high topographic elevations compared with the Bay, so more drying of these sediments is expected than at the Alviso Complex. Hydrologic modeling conducted for the ISP indicates that 2C system (ponds 6, 5, 6C, 4C, 3C, 5C, 1C, and 2C) will have average water depths about 0.1 to 1 foot higher than existing conditions, although some of those ponds (1C and 5C) will still be seasonal. The remaining ponds will have average water depths about 0.5 to 2 feet lower than existing conditions. Average water depths in the Baumberg Complex will range from zero to about 2.5 feet in summer, and about one to 2.5 feet in winter. Hydrologic modeling results indicate that water levels will vary by about 0.5 feet due to weather and tides. Water levels under the ISP are therefore likely to expose the pond bottom for some portion of the year.

Since the water regime of the Baumberg Complex will vary from exposed mud to about 3 feet of water, the ponds are likely to be used by a wide range of foraging shorebirds and waterfowl. Given the generally high sediment elevations, some amount of drying and aeration of sediment can be expected in summer and on weak tide cycles. The ISP will result in shallower ponds. While there is some potential for oxidation, methylation and increased mobilization of inorganics due to this hydrologic regime, available data indicate that inorganics are present in sediment at concentrations at or below ambient conditions. Therefore, the risk of adverse effects on water quality and wildlife is unlikely to be greater than that posed by ambient bay sediment.

2.3.1.2.2 Baumberg Complex Management and Monitoring:

Some preliminary recommendations for management and monitoring are described in Chapter 4. Management and monitoring activities will be developed and evaluated through the CEQA/NEPA and permitting processes.

2.3.1.3 West Bay Complex

Assessment of sediment quality in the West Bay Complex has a high degree of uncertainty due to the fact that only one sample is available. See Table 2.3.1.3. However, concentrations of all inorganics in that sample were well below San Francisco Bay ambient conditions and RWQCB cover criteria. With the exception of nickel, which exists naturally in the Bay at concentrations above its Low Effects Range (ER-L), the detected concentrations were also below ER-Ls. While it is not possible to characterize sediment definitively on the basis of a single sample, the available data indicate that inorganics are present in the West Bay Complex at concentrations below background conditions and are unlikely to adversely affect water quality or wildlife.

Table 2.3.1.3

West Bay Complex Inorganic Sediments
Data Source: Hydroscience

Units = mg/kg dry weight

Method No.	EPA 6020	EPA 6020	EPA 6020	EPA 6020	EPA 6020	EPA 7471	EPA 6020	EPA 6020	EPA 6020	EPA 6020
Pond No.	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Lead**	**Mercury**	**Nickel**	**Selenium**	**Silver**	**Zinc**
1-RC-S	6.63	0.226	53.6	19.2	7.77	0.0911	55.7	0.533	ND	50.1

2.3.1.3.1 West Bay Complex Hydrologic Changes

The hydrologic modeling results are presented in Section 4.2.13 of Chapter 4. These results indicate that the ponds will continue to be operated as continuous circulation ponds with water depths of at least one foot. Some ponds may be converted to muted tidal action.

2.3.1.3.2 West Bay Complex Management and Monitoring

Based on available data, concentrations of inorganics in the West Bay Complex are below Bay ambient conditions, and no special management considerations are advisable. Further sediment characterization is advisable to confirm the results of initial sampling. Based on the results of this sampling, limited future water quality monitoring should be conducted in this area to confirm that water quality is not affected.

2.4 Hydrology and Water Quality

Water quality in the ISP was characterized based on available surface water analytical data. Inorganics data were as collected from a representative subset of 11 ponds in the Alviso, Baumberg, and the Cargill Plant at Newark. Ponds were selected for sampling based on their salinity (See Table 2.4.1-1)). Seven of the 11 sampled ponds will actually discharge saline water during the initial stewardship period. However, pond selection was not primarily based on whether the selected ponds would be part of the actual circulation pattern. Rather, the selected ponds, exhibiting a range of salinities, were intended to serve as surrogates for the full complement of ponds in the planned circulation system. The objective was to determine concentrations of inorganics in a group of ponds that exhibited the range of salinities that might be circulated to the Bay and adjoining sloughs during the initial stewardship period. Since salinity increases with greater distance from water intake points, selection of a subgroup of ponds with a representative range of salinity is also approximates the likely variability in chemical concentrations due to proximity to Bay sources and potential concentration of metals.

Table 2.4-1

Concentrations of Inorganics in ISP Ponds[a]

		Dissolved Concentration									
Pond No.	**Salinity**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Lead**	**Mercury**	**Nickel**	**Selenium**	**Silver**	**Zinc**
	(g/L)	**(µg/L)**	**(µg/L)**	**(µg/L)**	**(µg/L)**	**(µg/L)**	**(µg/L)**	**(µg/L)**	**(µg/L)**	**(µg/L)**	**(µg/L)**
A2W	31.6	6.27	0.049	1.22	1.06	0.264	0.00126	8.05	0.199	0.012	1.21
A3W	42.0	10.7	0.044	1.22	1.10	0.307	0.00126	7.45	0.128	0.010	0.65
B2C	54.6	1.14	0.054	1.24	1.29	0.280	0.00036	4.96	0.055	0.016	1.18
A15	89.4	14.0	0.077	1.12	0.86	0.313	0.00138	10.8	0.094	0.021	1.29
A51	89.8	14.5	0.067	1.16	0.89	0.330	0.00128	10.6	0.124	0.027	1.83
A14	92.6	18.3	0.039	1.35	0.97	0.309	0.00221	11.0	0.111	0.055	1.15
A16	109	14.4	0.053	1.27	1.07	0.446	0.00398	12.8	0.141	0.040	2.25
A18	146	48.3	0.899 [b]	1.35	1.92	0.748	0.00114	19.7	0.224	0.023	2.88
I-3	194	3.52	0.096	1.16	0.57	0.572	0.00056	10.8	0.304	0.015	2.87
I-3B	224	3.14	0.124	1.47	2.64	1.33	0.00069	13.3	0.142	0.039	4.02
B9	279	30.9	0.423	1.34	2.21	7.18	0.00041	14.5	0.140	0.028	3.80

	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Zinc
WQO – Alviso Complex (California Toxics Rule)										
Continuous	36	9.3	50	9[c]	8.1	-	8.2	-	1.9	81
Maximum	69	42	1100	5.3[c]	210	-	74	-	-	90
WQO – Baumberg Complex (Basin Plan)										
4-hour Average	36	9.3	50	6.9[d]	5.6	-	11.9	-	1.9	58
1-hour Average	69	43	1100	10.8[d]	140	-	62.4	-	-	170

Table 2.4-1

Concentrations of Inorganics in ISP Ponds[a]

(Continued)

		Total Recoverable Concentration									
Pond No.	Salinity	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Zinc
	(g/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
A2W	31.6	6.36	0.063	2.36	2.15	0.843	0.012	11.8	0.274	0.022	1.80
A3W	42.0	11.9	0.045	0.67	1.24	0.324	0.0048	8.42	0.173	0.015	0.79
B2C	54.6	1.00	0.050	0.67	1.59	0.392	0.0034	7.09	0.092	0.013	1.28
A15	89.4	15.1	0.054	0.83	1.37	0.351	0.032	14.3	0.160	0.030	1.82
A51	89.8	15.7	0.054	1.07	1.59	0.371	0.032	15.7	0.135	0.020	3.07
A14	92.6	20.1	0.053	1.17	2.04	0.395	0.044	13.5	0.220	0.063	3.16
A16	109	17.1	0.062	1.23	2.01	0.619	0.039	18.1	0.159	0.150	3.38
A18	146	56.2	0.119	1.30	3.39	1.37	0.050	21.8	0.310	0.045	4.49
I-3	194	4.28	0.119	1.47	2.07	0.892	0.036	9.73	0.295	0.128	6.77
I-3B	224	5.18	0.136	1.38	2.45	1.15	0.041	12.3	0.352	0.044	7.22
B9	279	33.1	0.123	1.12	2.61	6.48	0.030	15.1	0.143	0.416	4.28

	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Zinc
WQO – Alviso Complex										
Continuous	-	-	-	-	-	0.051	-	5	-	-
Maximum	-	-	-	-	-	-	-	-	-	-
WQO – Baumberg Complex										
4-hour Average	-	-	-	-	-	0.025	-	5	-	-
1-hour Average	-	-	-	-	-	-	-	-	-	-

Table 2.4-1

Concentrations of Inorganics in ISP Ponds[a]

(Concluded)

Notes: [a] Source: Frontier Geosciences (November 11, 2002). Samples collected October 26, 2002

[b] Possible contamination suspected

[c] Values shown are site-specific criteria obtained from the RWQCB

[d] Values shown are site-specific criteria for the South Bay adopted on May 22, 2002 as an amendment to the Bay Plan

= Exceedence of applicable water quality objective

WQO = Water Quality Objective

μg/L = Micrograms per Liter

Existing concentrations of organic compounds in the South Bay salt ponds were evaluated based on available surface water quality data from the Alviso, Baumberg, and West Bay Complexes (See Appendix A). Available organics data for surface water include petroleum hydrocarbons, dioxins/furans, and SVOCs. These chemicals were detected in surface water at concentrations similar to ambient conditions in uncontaminated areas of San Francisco Bay. Based on these results and the low concentrations of these and other organics (including semi-volatile organic compounds and polynuclear aromatic hydrocarbons) observed in groundwater samples collected for the ISP and by others (see Appendix A), organics are unlikely to be present in ISP ponds in excess of background conditions or applicable water quality objectives (WQOs). Therefore, the organic contaminant data are not discussed in detail.

Analytical results for inorganics are presented in Table 2.4-1. The salinity of each sample is presented along with the dissolved and total recoverable concentrations of each of the ten metals of interest. Table 2.4-1 also provides applicable water quality objectives for the Alviso and Baumberg Complexes. Water quality objectives applicable to the Baumberg Complex are listed in the most recent version of the Water Quality Control Plan. San Francisco Bay Basin (Region 2) (RWQCB, 1995), including a May 22, 2002 amendment adopting site-specific WQOs for the South Bay. Objectives applicable to the Alviso Complex are listed in the Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California; Rule. Federal Register Volume 65, No. 97. May 18 (40 CFR Part 131) (U.S. EPA, 2000) and are specified as dissolved concentrations, except for mercury and selenium, which are specified as total recoverable concentrations.

In order to assess the water quality a comparison was made between the detected concentrations of each of the metals of concern in the sampled ponds and the WQOs applicable to each area. All detected concentrations of arsenic, cadmium, chromium, copper, selenium, silver and zinc were well below applicable WQOs. Only nickel and mercury were detected at concentrations exceeding WQOs.

Concentrations of nickel in eight of the sampled ponds exceeded applicable water quality criteria. The lowest concentrations were detected in the lower salinity Alviso ponds (A2W, A3W, and B2C); nickel was detected in these ponds at concentrations from 4.96 to 8.05 µg/L; these values are below the CTR limit of 8.2 µg/L. Concentrations of nickel detected in the remaining Alviso ponds exceeded the CTR limit; those concentrations ranged from 10.6 µg/L (slightly above the CTR limit) to 19.7 µg/L (more than twice the CTR limit). Nickel concentrations may be correlated with salinity. At higher salinities (89.4 to 279 ppt) detected concentrations of nickel were generally higher (10.6 to 19.7 µg/L), while in lower salinity ponds (31.6 to 54.6 ppt) nickel concentrations were lower (4.96 to 8.05 µg/L).

Detected concentrations of total mercury ranged from 0.0034 to 0.050 µg/L. Detected concentrations in the Alviso Complex were below the CTR limit of 0.051 µg/L. In ponds I-3, I-3B, and the Baumberg Complex, detected concentrations of mercury slightly exceeded the Water Quality Control Plan San Francisco Bay Basin (Region 2) Board (RWQCB, 1955,) limit of 0.021 µg/L. Concentrations of mercury may be correlated with salinity. Detected concentrations in the ponds with lower salinity (31.6 to 54.6 ppt) ranged from 0.0034 to 0.12 µg/L, close to an order of magnitude lower than concentrations detected in ponds with salinities of 89.4 ppt and greater (0.032 to 0.050 µg/L).

In summary, available data indicate that concentrations of all inorganics except nickel and mercury are present in the ISP ponds at concentrations well below applicable WQOs. The elevated detections of mercury and nickel indicate that these metals may be present in the ISP ponds at concentrations exceeding applicable WQOs.

2.5 Hydraulic Setting

2.5.1 Physical Setting of South San Francisco Bay and Associated Tidal Sloughs

South San Francisco Bay (SSFB) is defined as the portion of San Francisco Bay south of the Oakland Bay Bridge. The length of SSFB from the Oakland Bay Bridge to the southern end at Coyote Creek is approximately 50 kilometers. The width of SSFB varies from less than 2 kilometers near the Dumbarton Bridge to approximately 20 km north of the San Mateo Bridge. SSFB consists of broad shoals and a deep relict river channel (Walters, 1982). The mean depth of SSFB is less than 4 meters while the channel is typically 10-15 meters deep. Intertidal areas typically contain a system of small branching channels that effectively drain these areas at low water.

2.5.1.1 South San Francisco Bay

SSFB is a complex and dynamic estuarine system influenced by ocean tides, winds and freshwater flows from tributaries to SSFB. For this reason the hydrodynamic properties of SSFB vary strongly in space and in time.

2.5.1.1.1 Hydrodynamics

The hydrodynamics of SSFB are fairly well understood due to extensive data collection (e.g., Cheng & Gartner, 1984) and modeling efforts (e.g., Cheng et. al., 1993 and Gross et. al., 1999a). Currents in SSFB are dominantly tidally driven, while wind and density-driven currents are relatively much less important (e.g., Walters et. al., 1985). Tidal amplitude increases as tides propagate from Central SSFB. The mean tidal range at the Golden Gate Bridge is 1.25 meters, the tidal range at Alameda is 1.45 meters and the tidal range at the Dumbarton Bridge is 2.00 meters (NOAA, 2003). The tides in SSFB are “mixed semidiurnal” meaning that high water occurs twice daily and that the daily higher high water elevation can be significantly higher than the daily lower high water elevation. As an example, measured water surface elevation at the Dumbarton Bridge shown during a two-week period at the beginning of 1980 on Figure 2-1. The diurnal inequality in the tides is apparent in this data, as well as the fortnightly spring-neap cycle.

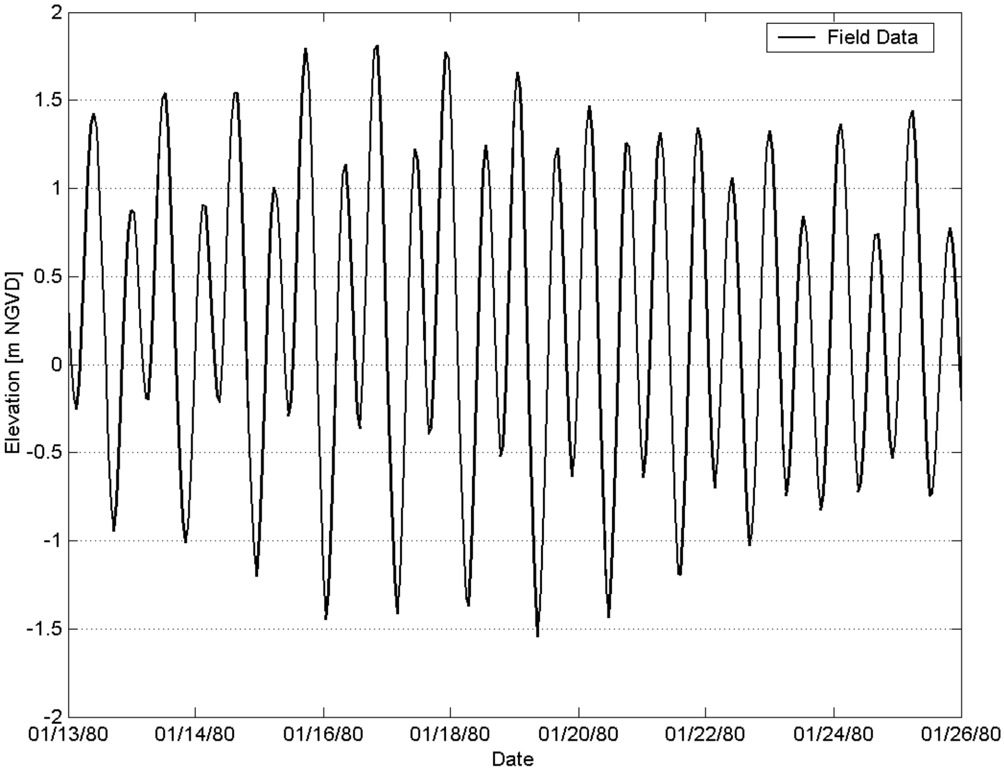


Figure 2-1
Observed Water Surface Elevation at NOAA Station 9414509, Located at the Dumbarton Bridge

Tidal currents are stronger in the channel than in the shoals (Walters et. al., 1985) and slack water generally occurs in the shoal regions before the channel. Table 2.5.1.1.1shows the root mean square (RMS) speed and depth for different stations and Figure 2-2 shows the variability of RMS speed with depth using the data in Table 2.5.1.1.1 (Cheng & Gartner, 1984). Tidal currents also show significant diurnal inequality and temporal variability on the fortnightly spring-neap cycle as shown for United States Geological Service (USGS) station C13, located near the Dumbarton Bridge (Cheng and Gartner, 1984), on Figure 2-3.

Table 2.5.1.1.1

Water depth, RMS Speed and Other Information Regarding Mechanical Current Meter Data Collected in South San Francisco Bay

Station	Meter Depth (meters)	Water Depth (meters)	RMS Speed (cm/s)	Start of Record	End of Record
c9	4.5	7.6	36.4	6/21/80	7/23/80
c307	3.0	4.6	20.0	8/6/80	8/23/80
gs27	3.3	9.4	43.4	2/4/81	3/5/81
gs28	2.7	8.8	38.1	4/21/83	6/1/83
c10	0.6	2.1	28.4	8/19/80	9/4/80
3sw84	1.5	2.6	21.6	8/9/84	9/6/84
gs29	7.0	13.1	40.0	1/27/82	2/21/82
c312	6.1	14.3	46.6	6/6/80	6/25/80
gs30	6.7	12.1	43.9	3/16/83	4/14/83
c313	1.2	2.1	20.9	6/26/80	7/11/80
c12	5.8	14.3	54.3	5/21/80	6/6/80
gs31	4.5	12.1	49.1	3/16/83	4/21/83
gs9	5.1	9.1	46.9	2/1/79	2/28/79
c13	7.6	13.7	43.7	7/10/80	8/9/80
c14	4.9	6.4	33.4	5/28/80	6/13/80

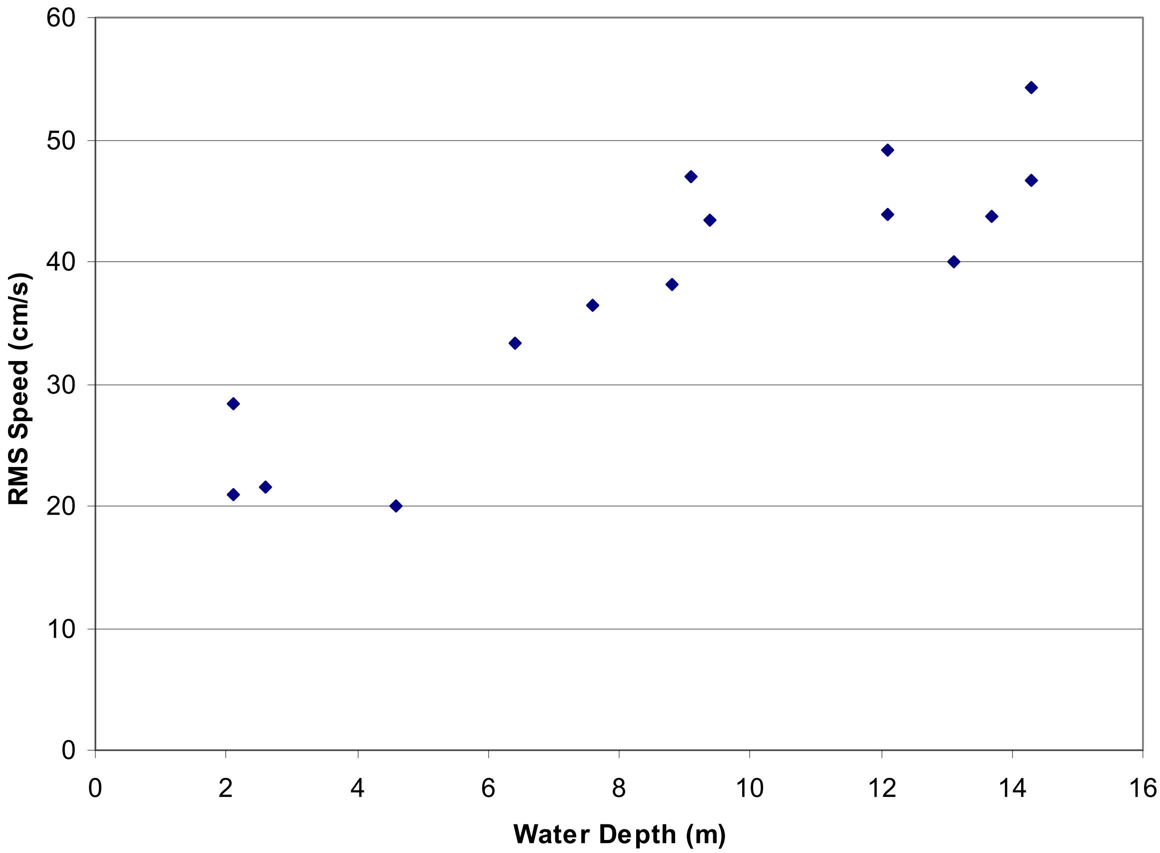


Figure 2-2
RMS Speed Versus Water Depth for South San Francisco Bay Current Meter Data

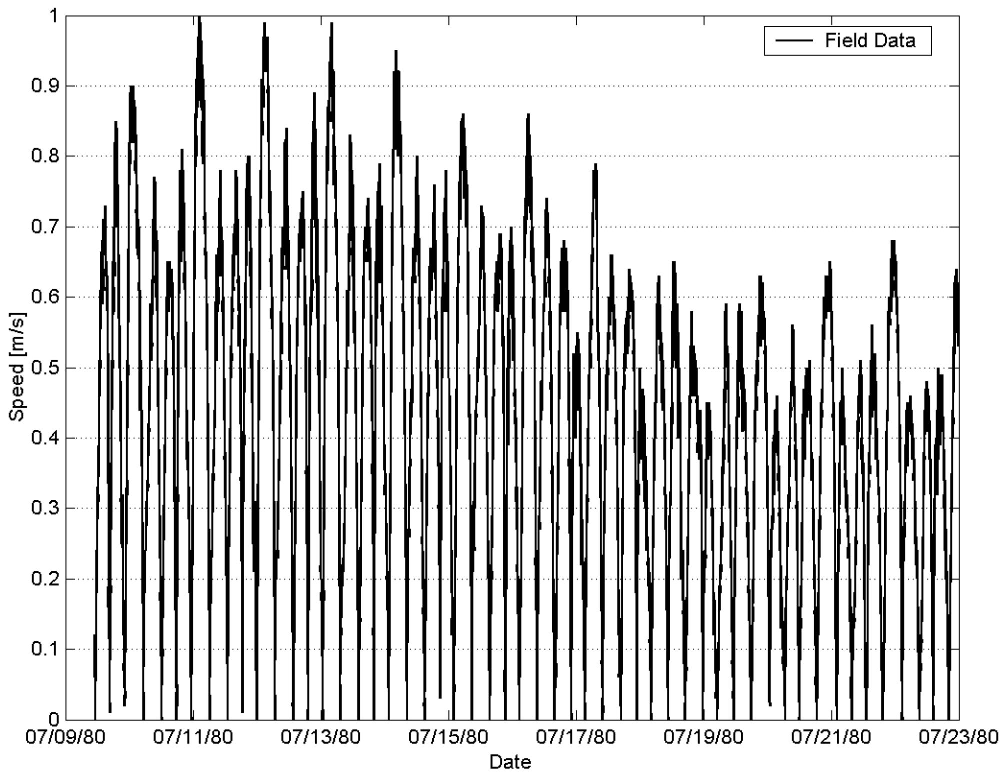


Figure 2-3
Observed Current Speed at Station C13, Located near the Dumbarton Bridge

Most freshwater inflow enters SSFB during the winter and spring. During summer there is little freshwater inflow to SSFB and most of this freshwater inflow is effluent from municipal wastewater treatment plants. The largest tributaries to SSFB are Alameda Creek, which flows into Alameda Flood Control Channel, Guadalupe River, which flows into Alviso Slough and Coyote Creek, which becomes a tidal slough and connects to SSFB. Streamflow is both highly variable during the year and among years. For example, the average gauged flow at USGS station #11179000 (Alameda Creek near Niles) during February is 12.5 cms, while the average gauged flow during October is 0.4 cms. During February of 1994 the average gauged flow at this location was 3.7 cms while during February of 1998 the average was 105.2 cms (USGS, 2003). The flows entering Alameda Flood Control Channel from Alameda Creek during 1994 and 1995 are shown on Figure 2-4. This period shows the dynamic nature of inflows, with low summer flows and much larger flows during the winter of 1995 (a relatively wet year) than during the winter of 1994 (a relatively dry year). Other tributaries also show orders of magnitude variability in flow on seasonal and annual time scales.

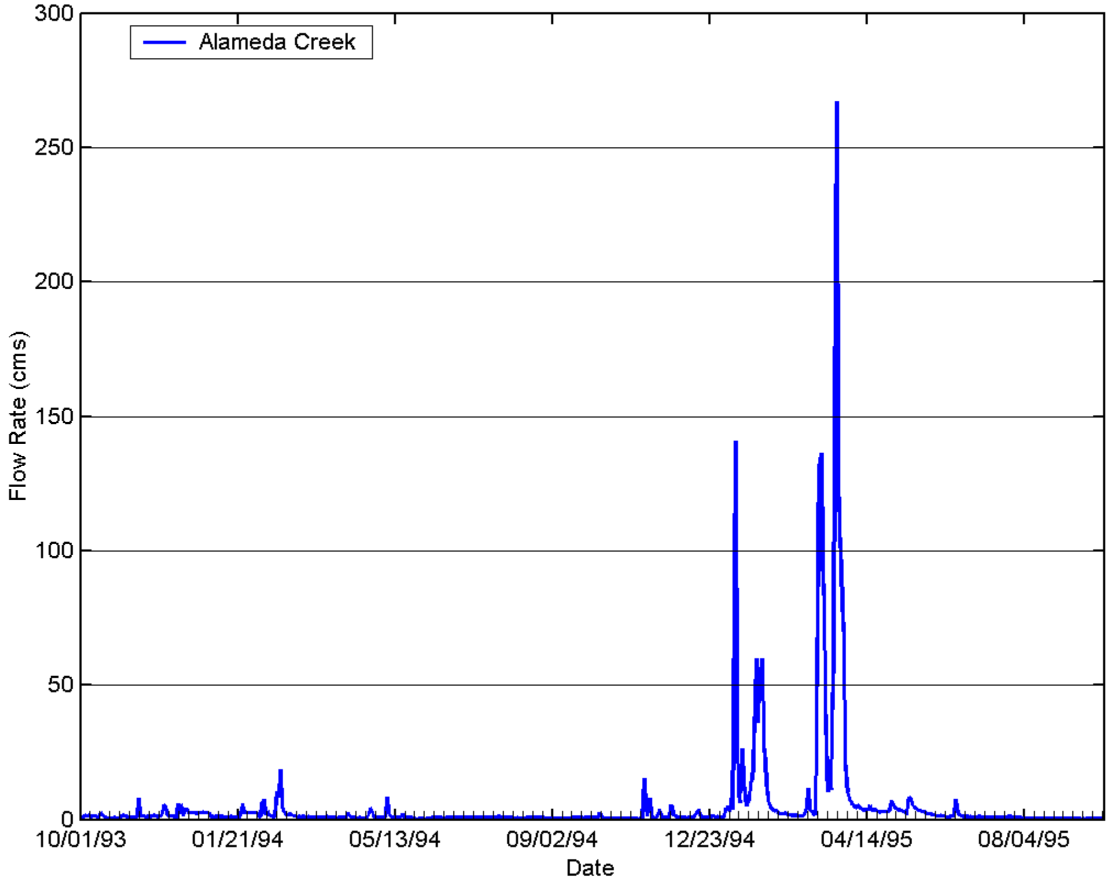


Figure 2-4
Flow rate from Alameda Creek to Alameda Flood Control Channel

2.5.2 South San Francisco Bay Salinity

Salinity in SSFB is dependent on:

- Salinity in Central Bay and exchange between SSFB and Central Bay
- Freshwater input to SSFB
- Evaporation.

Seasonal and yearly variations in salinity are driven primarily by variability in freshwater flow. During periods of high freshwater inflow salinity can vary substantially in SSFB resulting in dynamic three-dimensional circulation patterns (McCulloch, 1970). A key feature of these circulation patterns is density-driven exchange between SSFB and Central Bay (Walters et. al., 1985). Therefore, winter salinity conditions in SSFB are dynamic, characterized by unsteady inflows, variable salinity and periodic vertical stratification. When freshwater flows decrease, generally in late spring, the salinity of SSFB gradually increases as water of oceanic salinity mixes into SSFB from the ocean (via Central Bay). During summer the largest sources of freshwater input to SSFB are wastewater treatment plants and their flows are the same order of magnitude as evaporation in SSFB (Denton and Hunt, 1986). Therefore, salinity is relatively uniform and typically near oceanic (33 ppt) during late summer and fall.

Continuous observations of salinity are made by the USGS at station 162700, located at the west end of the Oakland Bay Bridge, and station 162765, located at the San Mateo Bridge on the east side of the ship channel. At both stations, salinity is measured continuously by two sensors: a “top” sensor and a “bottom” sensor. Data at the Oakland Bay Bridge is collected 2.7 m below mean lower low water (MLLW) and 12.0 m below MLLW. Data from the San Mateo Bridge is collected 1.7 m below MLLW and 13.9 m below MLLW. USGS salinity data are also available near the Dumbarton Bridge (on the east span of the old Dumbarton Bridge) at a single sensor located 2 m from the bed (Schemel, 1998). Figure 2-5 shows salinity measured at the bottom sensor at the San Mateo Bridge salinity station from February 1994 through August 1995. Observed salinity at this location is strongly inversely related to freshwater inflow and varies from over 30 ppt during the summer of 1994 to less than 10 ppt during March of 1995. A similar trend is shown at the Dumbarton Bridge station, where salinity observed between November 1994 and August 1995 varies from less than 1 ppt to more than 31 ppt, as shown on Figure 2-6. In addition, the salinity at this location also varies substantially over the tidal cycle, as indicated on Figure 2-7.

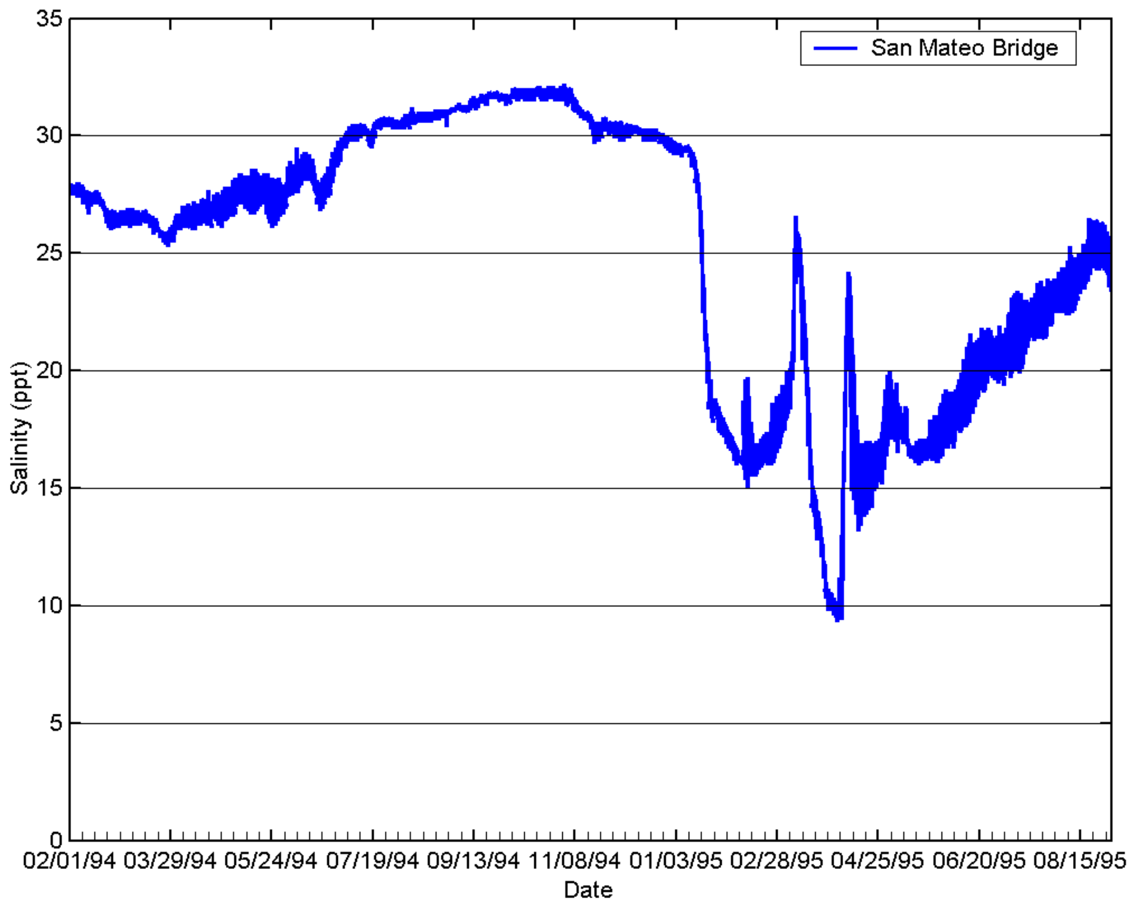


Figure 2-5
Observed Bottom Sensor Salinity at USGS Station 162765, Located at the San Mateo Bridge

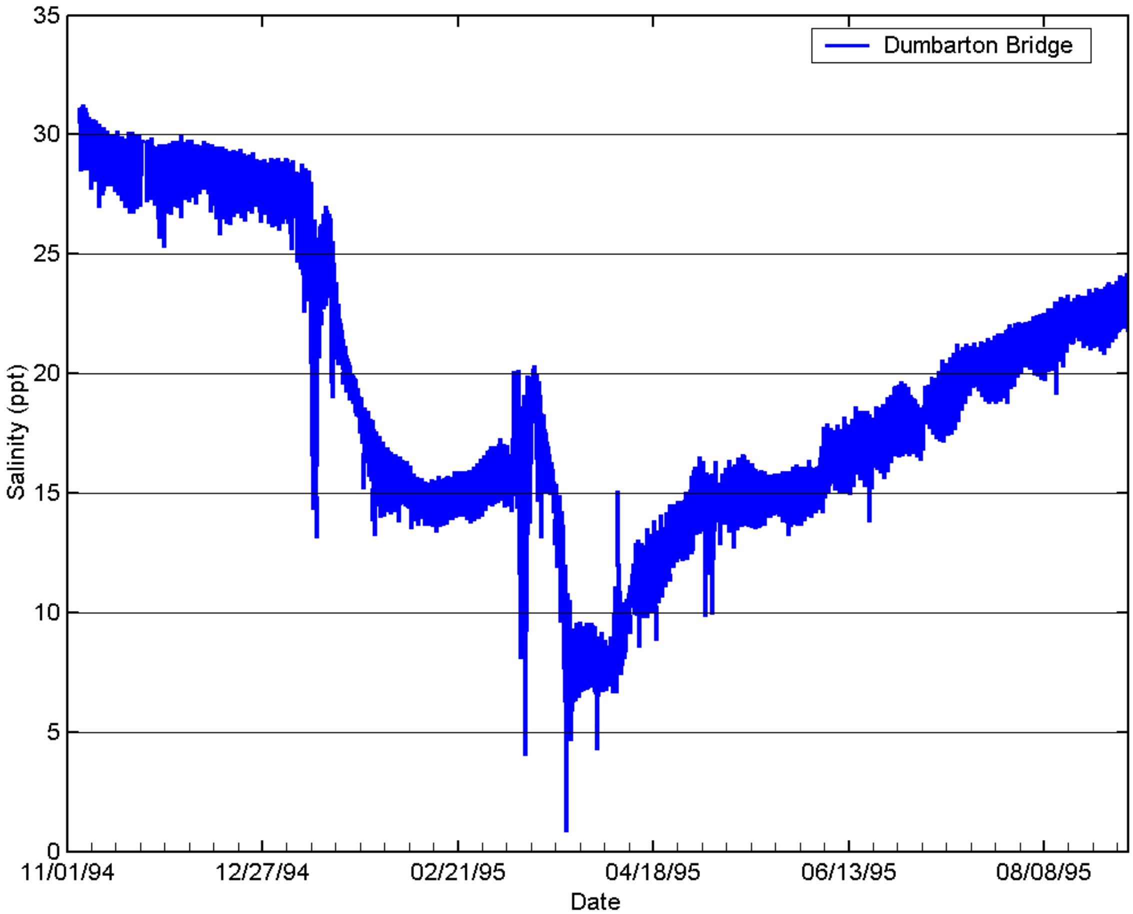


Figure 2-6
Observed salinity near the Dumbarton Bridge.

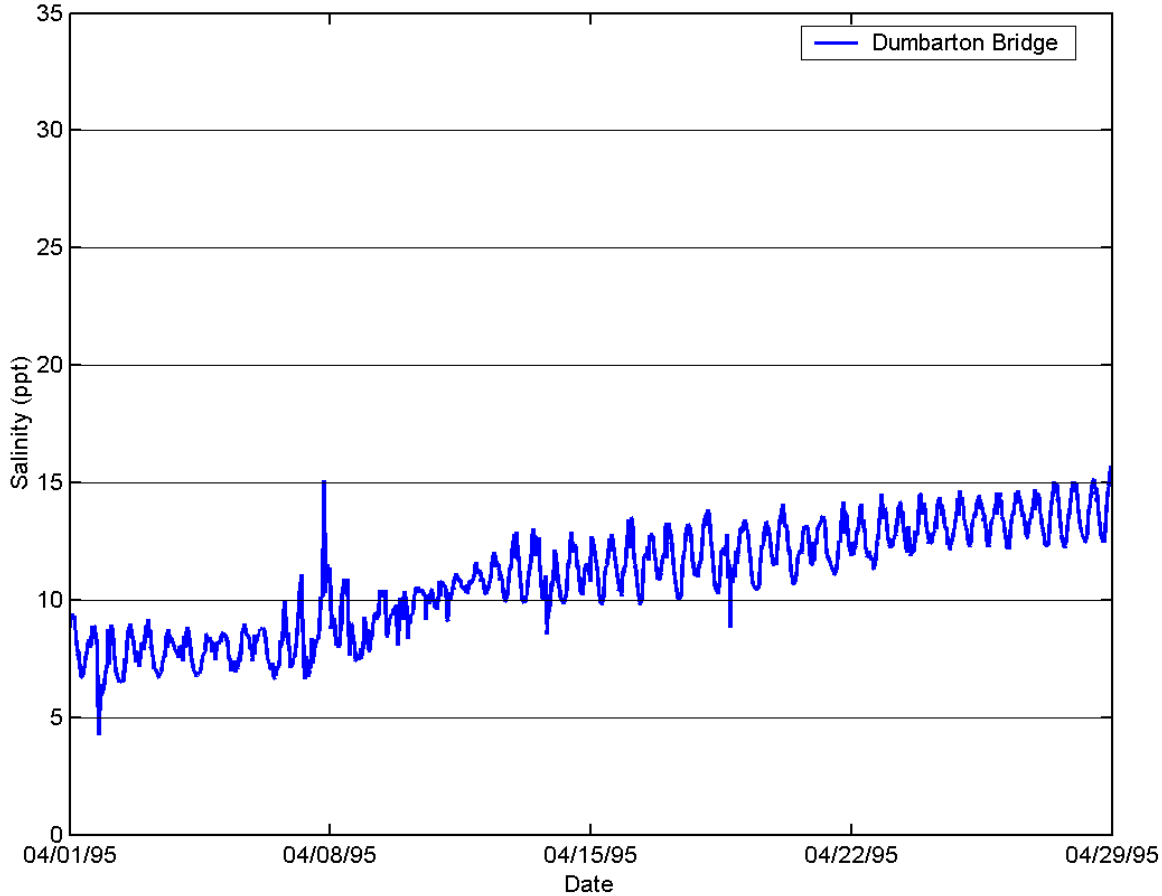


Figure 2-7
Observed Salinity near the Dumbarton Bridge during April 1995

The USGS has collected detailed salinity data in San Francisco Bay since 1969 as part of the pilot Regional Monitoring Program (e.g., Edmunds et. al., 1995). These data are collected at least once a month at a maximum of 17 stations in the channel of SSFB extending from the Oakland Bay Bridge to the mouth of Coyote Creek. Since 1988 this data has been reported in 1 meter vertical intervals. This data (from 1988 to 2000) has been analyzed to indicate the temporal variability of salinity in SSFB. In Figure 2-8, the variability of observed salinity at station 30, located in the main channel of SSFB directly west of the Baumberg System, is shown for all data collected during February between 1988 and 2000. Salinity values ranging from 8 ppt to 31 ppt, have been measured during winter and spring. A large range of salinity has also been observed at Station 36, located in the main channel of SSFB near the Alviso System. At this location, the minimum salinity recorded during February was 4 ppt, while the maximum salinity was 26, as shown in Figure 2-9.

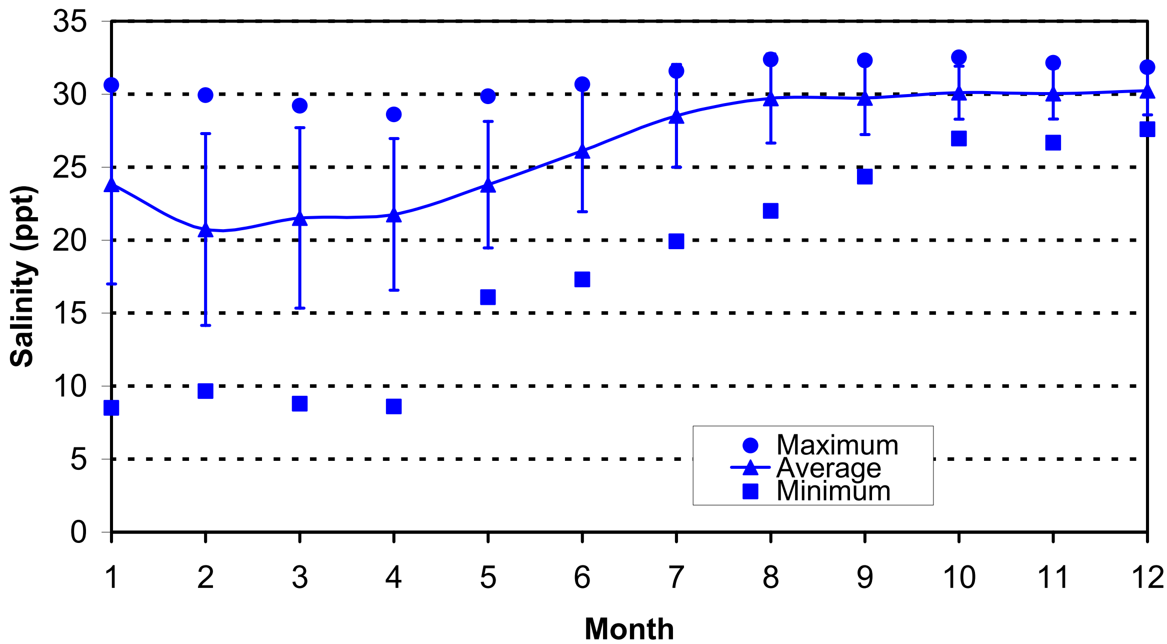


Figure 2-8
Variability of Observed Salinity at Pilot RMP Station 30

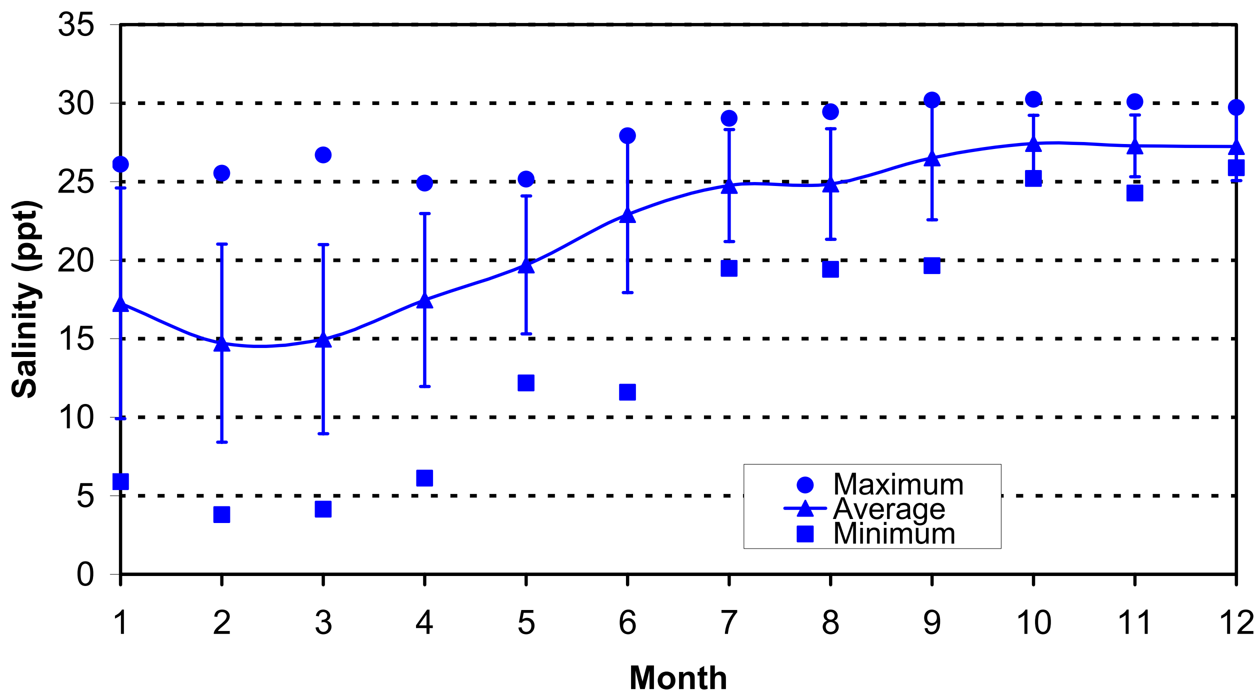


Figure 2-9
Variability of Observed Salinity at Pilot RMP Station 36

2.5.3 South San Francisco Bay Tidal Sloughs

2.5.3.1 Tidal Sloughs near the Alviso System

The Alviso System is located in Lower South Bay, defined as the portion of SSFB location landward (south) of the Dumbarton Bridge. Lower South Bay is a relatively shallow subembayment with an average depth of 2.6 m at mean tide. Tides in this region are particularly strong due to amplification of tidal energy with distance landward in SSFB. Because of the strong tides and small depths, “the area covered by water in Lower South Bay at mean lower low water (MLLW) is less than half the surface area at mean higher high water (MHHW) indicated that over half of Lower South Bay consists of shallow mudflats that are exposed at low tides” (Schemel, 1998). Furthermore the volume of water in Lower South Bay at MLLW is less than half of the volume of water at MHHW, indicating that more than half of the water volume present in Lower South Bay at high water can pass through the Dumbarton Bridge during a single ebb tide (Schemel, 1998). Near bottom salinity measured continuously by the USGS at the Dumbarton Bridge from 1995 to 1998 was highly correlated with freshwater flows and varied from approximately 5 ppt to 32 ppt (Schemel, 1998). The daily range of measured salinity at the Dumbarton Bridge can also be large, particularly during winter, when the daily range is typically 5 ppt.

The tidal sloughs that border the Alviso salt ponds are Coyote Creek, Mud Slough, Artesian Slough, Alviso Slough, Guadalupe Slough, Stevens Creek, Mountain View Slough and Charleston Slough. (See Figure 1-3 in Chapter 1.)

The largest tidal slough is Coyote Creek, which meets SSFB at Calaveras Point. Coyote Creek is a substantial source of freshwater during winter and spring. Salt marsh regions are present in several parts of Coyote Creek, particularly bordering salt ponds. The bottom elevation of the main channel of Coyote Creek ranges from -1 to -4 m NGVD. The tidal range in Coyote Creek, reported as 2.2 m at NOAA Station 9414575 (NOAA, 2003), is particularly large.

Artesian Slough borders ponds Alviso A16 and Alviso A17 and is a tributary to Coyote Creek. The discharge from the City of San Jose municipal wastewater treatment plant enters the upstream end or Artesian Slough with a flow of approximately 133 megagallons per day (mgd) (Davis et. al., 2000). For this reason, Artesian Slough generally has relatively low salinity (Kinnetic Labs, 1987).

Strong salinity gradients are present in both Coyote Creek and Artesian Slough (Kinnetic Labs, 1987) and frequently result in vertical salinity stratification (Simons, 2000). Observations of salinity suggest that, during winter Coyote Creek is periodically stratified while Artesian Slough is persistently stratified (Simons, 2000). The daily range of salinity in Coyote Creek can be quite large. In a one week duration data set collected in late January and early February 2000, measured salinity typically ranged from approximately 3 ppt to over 20 ppt during most days (Simons, 2000), as shown in Figure 2-10. Salinity is also highly variable seasonally, with lower salinity during winter and spring, in Coyote Creek and Artesian Slough (Kinnetic Labs, 1987)

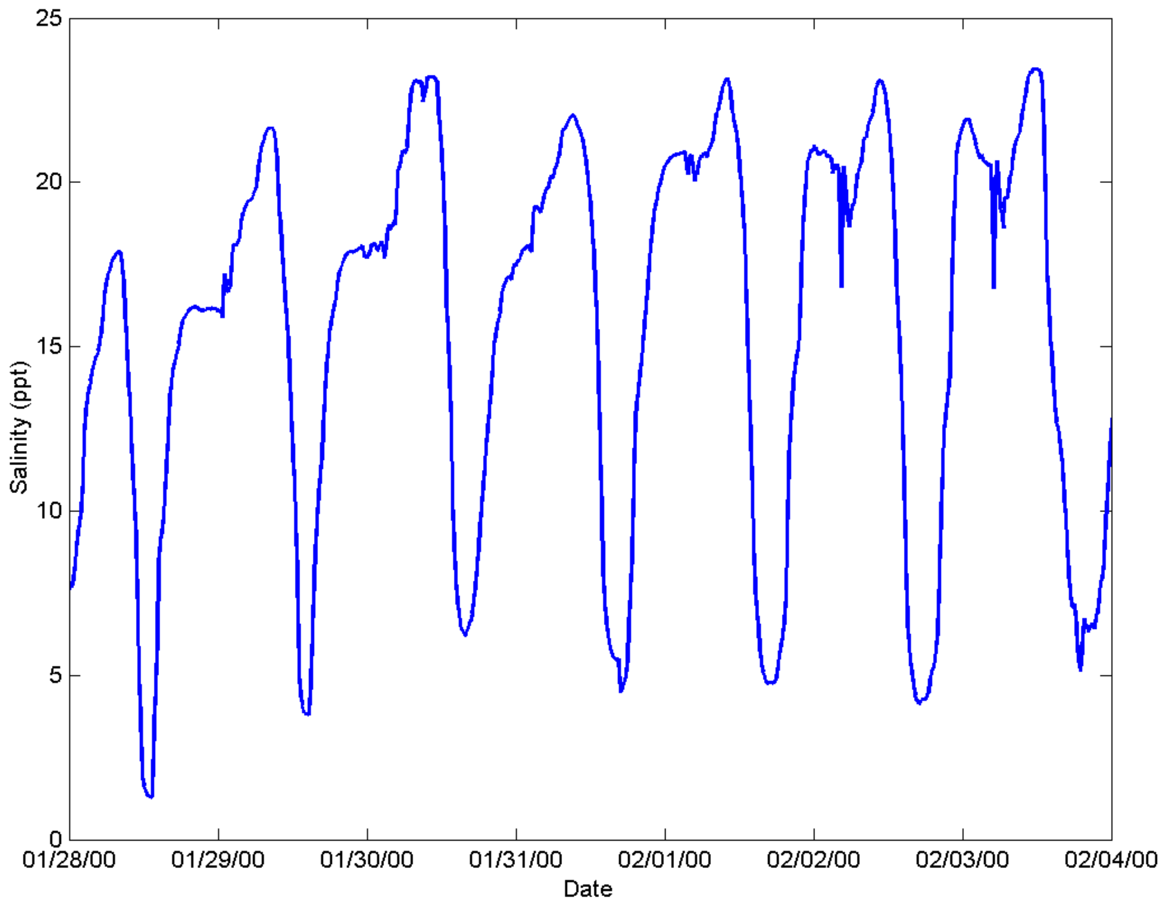


Figure 2-10
Observed Bottom Sensor Salinity in Coyote Creek, near Mud Slough

At the western end of pond Alviso A21, Mud Slough splits off from Coyote Creek and, bordering ponds Alviso A21, A20 and A19, continues landward to connect with Warm Springs marsh restoration area. Mud Slough is a shallow tidal slough, which receives minimal freshwater input during all seasons.

Alviso Slough borders ponds Alviso A7, A8, A9, A10, A11 and A12. Guadalupe River, the second largest tributary to SSFB in terms of drainage area and flow after Alameda Creek, discharges to Alviso Slough. The bottom elevation of Alviso Slough ranges from -1 to -3 m NGVD. The tidal range in Alviso Slough is particularly large with measured high water approximately a factor of 1.6 higher (relative to mean tide) than high water at the Golden Gate Bridge (NOAA, 2003). Given the combination of strong tides and shallow depths in Alviso Slough it is clear that most of the volume present in Alviso Slough at high water drains to Coyote Creek (and subsequently SSFB) during ebb tide. Therefore this slough, as well as Coyote Creek and Guadalupe Slough, actively exchanges water with SSFB due to tidal motions. Salinity is highly variable in Alviso Slough. Salinity observed near high water by Cargill at the mouth of Alviso Slough (measured by Cargill at the Alviso A9 intake) is generally similar to salinity measured at Dumbarton Bridge.

Guadalupe Slough borders ponds Alviso A3W, A4 and A5. Guadalupe Slough receives flow from Calabazas Creek and San Tomas Creek. The Sunnyvale municipal wastewater treatment plant also discharges to Guadalupe Slough (approximately 18 mgd) and is the primary source of freshwater to Guadalupe Slough during summer and fall. The bottom elevation of Guadalupe Slough ranges from -1 to -4 m NGVD. The tidal range in Guadalupe Slough is similar to the tidal range in Alviso Slough (NOAA, 2003). Measured salinity in Guadalupe Slough varies from 0 ppt to approximately 25 ppt (Kinnetic Labs, 1987). A strong salinity gradient along Guadalupe Slough during summer and fall conditions with salinity of approximately zero near the Sunnyvale WWTP discharge and measured salinity typically in the range of 10 to 20 ppt at the mouth of Guadalupe Slough (Kinnetics Labs, 1987).

Stevens Creek, Mountain View Slough and Charleston Slough are relatively shallow and narrow tidal sloughs, which contribute little freshwater flow to SSFB and drain relatively small areas.

2.5.3.2 Tidal Sloughs near the Baumberg System

The Baumberg System borders the eastern shore of SSFB and extends from Alameda Flood Control Channel on the south to San Mateo Bridge on the north. Relevant tidal sloughs flanking the Baumberg salt ponds are Alameda Flood Control Channel (AFCC), also known as Coyote Hills Slough, Old Alameda Creek, Mount Eden Creek and North Creek. (See Figure 1-2 in Chapter 1.) The region near the eastern shore of SSFB is a large mudflat.

The largest and most ecologically important slough in this region is Alameda Flood Control Channel (AFCC), also known as Coyote Hills Slough. Alameda Creek flows into AFCC. Alameda Creek, which drains an area of 633 square miles upstream of Niles (USGS, 2003), is the largest tributary to SSFB. The Army Corps of Engineers designed AFCC. The deepest part of the channel has bottom elevation of approximately -1.5 m NGVD near the mouth of AFCC and slopes gently up with distance upstream. The portion of AFCC that adjoins the salt ponds is tidal with high tide elevation slightly lower than the high tide elevation at San Mateo Bridge and low tide elevation considerably higher than low tide elevation at San Mateo Bridge (NOAA, 1933). Therefore the tidal range in AFCC is quite substantial but less than the tidal range in nearby portion of SSFB. Depths in the channel of AFCC typically range from 2 to 3 m at high water while, at low water, depths can be less than 1 m in the deepest part of AFCC. In addition, AFCC contains a large intertidal area that is only covered with water near high water and is drained during ebb tides. Therefore a large portion of the water volume that is present in AFCC at high water drains into SSFB during ebb tides. Salinity generally varies from bay salinity at the mouth of AFCC to freshwater arriving from Alameda Creek. During periods of high flow, freshwater can displace the bay water in AFCC and the salinity can be depressed significantly in SSFB near the mouth of AFCC (Huzzey et. al., 1990). However, the opposite pattern has also been noted, with higher salinity in the shoals than the channel, during periods of high Delta flow and relatively low local inflow in which less saline water enters SSFB from Central Bay primarily in the channel (Huzzey et. al., 1990).

The next tidal slough to the north of AFCC is Old Alameda Creek. Before Alameda Creek was diverted into Alameda Flood Control Channel, it drained into what is now known as Old Alameda Creek. Currently Old Alameda Creek receives minimal freshwater input. Currently Old Alameda Creek is comprised of two distinct channels, a narrow northern channel and a wider southern channel divided by a vegetated bar that is only submerged at higher high water during strong (spring) tides. A small amount of water level elevation data available in Old Alameda Creek indicates that high water elevations measured about 2 kilometers from the mouth of Old Alameda Creek as high are as 1.8 m NGVD and low water is typically near the bed elevation of -.5 m NGVD (Kamman Hydrology, 2000). Observed salinity in this slough, measured at a Cargill intake location, is generally similar to observed SSFB salinity.

Additional tidal sloughs are currently under construction in the Baumberg System. These sloughs are part of an ongoing tidal restoration project and are under construction using the Cargill dredge. When this restoration project is complete, Mount Eden Creek and North Creek will connect the Eden Landing Ecological Preserve to San Francisco Bay. North Creek will connect directly to Old Alameda Creek approximately 2 km from SSFB and Mount Eden Creek will enter the Bay approximately 2 km north of the mouth of Old Alameda Creek. These sloughs will not receive substantial freshwater flows and it is expected that salinity in these sloughs will be similar to bay salinity.

2.5.3.3 Tidal Sloughs near the West Bay System

The West Bay System is located on the western side of the Dumbarton Bridge. The Dumbarton Strait, with a width of approximately 2-km, is the narrowest part of SSFB. The mean tidal range in the Bay at this location is 2.0 m (NOAA, 2003) and the salinity is similar to the salinity measured by the USGS at the Dumbarton Bridge, shown on Figure 2-6 Observed velocities in this region, for example currents measured at USGS/NOAA station C13 (shown on Figure 2-3), are relatively large due to the strong tides and narrow cross-section of the Dumbarton Strait.

The largest tidal slough located near the West Bay System is Ravenswood Slough. (See Figure 1-4 in Chapter 1.) Local freshwater input to this slough is relatively low and salinity in the Bay and sloughs bordering the West Bay System is typically similar to salinity measured at the Dumbarton Bridge, shown in Figures 2-6 and 2-10 above.

3.0 Development of the Management Plan

3.1 Goals and Objectives

The goal of the ISP is to operate and maintain the South Bay Salt Ponds in an environmentally sound and cost effective manner while long-term restoration plans are developed and implemented.

The specific objectives of the ISP include:

- Cease salt production
- Circulate bay water through the ponds and introduce tidal hydrology to ponds where feasible
- Maintain existing open water and wetland habitat for the benefit of wildlife, including habitat for migratory shorebirds and waterfowl and resident breeding species
- Maintain ponds in a restorable condition to facilitate future long term restoration
- Meet all regulatory requirements, especially discharge requirements to maintain water quality standards in the South Bay.

In order to meet these objectives Bay water will be circulated through the pond system with sufficient volume to maintain pond salinities near Bay water salinity. This circulation allows salt production to stop, minimizes changes to existing pond water levels and habitat values, and maintains the ponds for future restoration. Several conditions exist that need to be considered in developing a cost-effective management philosophy and design.

Existing infrastructure limits flows through the existing pond system, because the system was constructed to maintain sufficient residence times in the ponds to increase the pond salinities. Therefore an interim operation similar to existing salt operations for the Alviso complex from A1 to A17, for example, would result in a high salinity discharge to Coyote Creek (near 150 ppt). This would not meet water quality objectives. In addition, the sale of pond A4 segments the Alviso system. Similarly, existing salt operations in Baumberg would result in a high salinity discharge to AFCC at pond 2C.

Therefore, the proposed project would segment the overall pond complexes into smaller systems where water would circulate from the Bay through a smaller number of ponds and discharge back to the Bay or slough. This approach has additional benefits for on-going operations and future restoration. The smaller systems mean the pond salinities are less dependent on the overall system operation, and allow a greater degree of control of water levels and salinity. This approach would also allow more flexibility in future restoration since one or more ponds could begin restoration without disrupting the operation of the entire complex.

The system segments were established based on logical physical groupings of ponds within the existing complexes. In particular, system separations were established at creek or slough crossings where siphons under the sloughs connect various ponds. The slough connections are generally the lowest capacity infrastructure in each complex, and are generally associated with a pump to force flow through the siphon. The slough locations are also points where a gravity outlet to the slough could be constructed.
The proposed new systems utilize most of the existing commercial salt operation infrastructure and general flow patterns. Therefore, most ponds include inflow and outflow locations at opposite ends of the pond. This improves mixing within the individual ponds.

Several systems include individual ponds or sub systems that are separate from the normal circulation patterns of the rest of the system. These ponds can be operated separately as batch ponds or seasonal ponds. The batch ponds can be operated to maintain longer residence times and higher pond salinities. The batch ponds do not discharge to a stream or slough, but outlet to another pond within the system to dilute any high salinity brines prior to any discharge to a stream or slough. These batch ponds could also be operated as seasonal ponds to be filled with Bay water or rainwater during the winter and drained or allowed to dry out during the summer.

3.2 Opportunities, Constraints, and Costs

The opportunities that the project will take advantage of are:

- Existing intakes. These conduits, gates, and channels have been in place for decades and are well understood by operational engineers.

- Existing connection infrastructure. Various structures between and among the ponds have been used for years to allow waters in various salinity conditions to flow between ponds in a controlled manner.

- Accessible Bay water for circulation. Each of the complexes described in the ISP has multiple potential access points for waters from San Francisco Bay to be admitted to control the water features of the ponds.

- Multiple locations for outlets. Each complex also has multiple exit points for water to be let back into the Bay. The inputs and outputs from the Bay maintain the salt ponds at acceptable water levels, salinity levels, habitat values, and potential restoration conditions.

The stewardship opportunities presented above also introduce constraints and associated project costs. Each of these constraints was evaluated during project planning and will continue to be monitored during the implementation of the ISP. The operations will be adjusted in near real time to produce the objectives.

These constraints are:

- Direction of water flow. Ponds generally have a singular flow direction and sequence established by existing pond bottom elevations and operational infrastructure.

- Existing salt pond levees. These levees, unless modified, may limit pond elevations.

- Existing pond connections. The maximum flow capacity of existing pond connections is limited by the structure size and the available water surface difference between ponds, although in some cases the connection may be replaced in order to establish greater flow potential.

- Flood control levees. The flood control levees have been built as part of public flood control projects. Construction and future pond operations must be consistent with the purposes and maintenance requirments of the flood control levees.

- Bottom elevations within ponds. High pond bottoms require high water surface elevations thereby reducing gravity inflow. In turn, low pond bottoms require low water surface elevations to minimize erosion from wave action. This also can reduce gravity outflows.

- Infrastructure effects. Because of the generally passive nature of the infrastructure, variations are induced in pond water levels during weak or strong tidal cycles and after rainfall events.

- Seasonal conditions. The high summer evaporation increases the need for circulation to minimize salinity increases. The low evaporation and rainfall during winter decreases the need for circulation of Bay water.

- Water Quality Objectives. WQO may limit long-term pond discharge salinities. The long term ISP operation must not degrade water quality to impact existing benefical uses in the receiving waters.

- Slough conditions. Because of the relative lack of water movement in sloughs discharges to sloughs are more sensitive to water quality concerns and will have to be monitored closely. In addition, salmonid migrations in specific creeks need to be protected.

The sum effect also means that the process of adapting the system operations may take several years to reach its final end state of system homeostasis.

The management cost of the South Bay Salt Ponds project, Initial Stewardship phase, will be minimized by taking advantage of the following:

- Existing infrastructure. By using and modifying the existing pond structures, the engineering and construction costs will be held to a minimum.

- Pumping. Pumping will be minimized by managing certain ponds seasonally to reduce the need for pumping.

- Monitoring. Monitoring, done by contractors, team participants, government agencies, or volunteer organizations will be early, extensive, and flexible. This will ensure that appropriate action can take place while costs for that action are their lowest.

- Operational Experience. The management team will examine, incorporate, and sustain existing operational experience in the management of the SSFB Salt Ponds. This management approach will simplify the ongoing transition of the salt ponds to wetlands.

3.3 Salinity Simulations

The key feature of the ISP is the circulation of Bay water through the ponds and release of this water to the receiving water sloughs and channels in South Bay. During the first period of circulation through the ponds, which will be referred to as the Initial Release period, the water currently in the ponds will be discharged to the Bay and replaced with Bay water brought into the ponds at the intakes. This will be a period of relatively rapid desalination. After the salinity is reduced to be similar to Bay salinity, it will be maintained by circulation of Bay water through the ponds. This circulation is different than the existing salt making operations because the pond systems will circulate water back to the Bay and because the flow rate through the ponds will be increased relative to existing flows. Following discharge into the receiving water bodies, there will be additional dilution of salinity due to the dynamic mixing forces within the South Bay environment.

Computer models were applied to estimate the water surface elevations, velocities and salinity within the ponds and receiving water bodies during the Initial Stewardship period. The pond model estimates inflows to the ponds from the Bay, flows between ponds, volume of water evaporated from the ponds, volume of water added to the ponds by precipitation and flow rates from the ponds to the Bay and sloughs. A three dimensional hydrodynamic model was used to estimate conditions in the Bay and sloughs.

This section provides a description of the pond modeling performed to evaluate the existing and proposed ISP pond conditions for elevation, flow, and salinity. The results of the pond modeling are described in

Chapter 4. The detailed description and simulation results of the hydrodynamic model are included in a separate report.

The initial release has been proposed to occur in April. April was selected to balance water quality and habitat concerns. The initial release of the higher salinity discharges during the late winter would have the least impact on maximum salinity values in the receiving waters. During the late winter the bay and slough salinities are generally low, and lower intake salinities would reduce the pond salinities more rapidly. Similarly, the lower bay and slough salinities would reduce the potential maximum salinities in the receiving water for a given discharge flow and salinity. Therefore, initial release during the winter would decrease the potential extent and duration of high salinities in the bays and sloughs due to the initial release.

However, the winter season from December to March is the period of the upstream migration of adult steelhead. The initial release salinity could affect the upstream migration of the adult salmon. The period from December to April is also period for the downstream migration of juvenile salmonids, including Chinook salmon and steelhead. In addition, March and April is the period with few bay shrimp in the bay and sloughs. April was proposed for most of the initial releases to avoid the adult steelhead migration, to be near the end of the juvenile salmonid migration period, and to be during the period with few bay shrimp.

Two additional initial release scenarios were modeled to include the permitted discharge salinity levels. The permitted discharge salinities are higher than the April 2002 recorded values. The additional initial release scenarios are described in Section 4.1.1.4.

3.3.1 Pond Model

In the ISP, the ponds are operated as a number of distinct pond systems each of which will contain one or more intake pond, which receives water from the Bay, and one or more release pond, which releases the water back to the Bay. Most of the pond systems contain a single intake pond and a single outlet pond and a single flow path through the ponds from the intake pond to the outlet pond.

The pond hydraulic computer model estimates inflows from the Bay, flows from the ponds to the Bay, evaporation from the ponds and rainfall on the ponds. However, in order to make pond hydraulic modeling feasible, some simplifying assumptions have been made. The following simplifying assumptions were made in formulating the pond hydraulic model:

- Each pond is considered to be well mixed.
- Each pond is treated as having a uniform bottom elevation.
- The flow through each pond system is assumed to be unidirectional from the intake pond to the outlet pond.

The model treats each pond as a single well-mixed volume and therefore does not estimate salinity variability within each pond. Data collected in the ponds under the existing operations indicates that they are generally well mixed.

The bottom elevation in each pond is specified as the average of available elevation data (Fremont Engineers, 1999) inside the pond. This data excludes borrow ditch areas, and levees.

The flow through each pond system is assumed to be unidirectional. Some of the ponds are connected by gaps in levees. Due to wind or density differences, flow may occasionally reverse direction through the gaps. The flow direction in the pond hydraulic model is assumed to be always from the intake pond to the outlet pond.

3.3.1.1 Hydraulic Information

Intake and outlet structures connecting the ponds to the Bay/sloughs will utilize gates to insure that flow is unidirectional through each structure. Outlet structures may also include weirs to maintain water elevations in the ponds. During Initial Stewardship, water will enter the ponds by gravity and/or pumping and be discharged by gravity.

The flow rates will vary over the tidal cycle depending on the difference in water level in the ponds and water level in the South Bay and associated sloughs where the culverts are located.

The infrastructure proposed in the ISP was selected to allow adequate flow rates to maintain discharge salinity close to Bay salinity during a dry year. The flows through the pond systems are substantially larger than flow rates for the existing commercial salt production operations. Increased flow rates result in decreased pond salinity by decreasing the average time required for water to travel from the inlet to the outlet allowing less time for evaporation. The hydraulic residence time (HRT) is defined as the average time required for water to circulate through a pond system. The HRTs corresponding to the ISP vary as tidal conditions vary, but are typically in the range of 15 to 50 days.

The relevant hydraulic information for each control structure is represented in the pond hydraulic computer model. The model accounts for the size and number of culverts at each inlet, outlet and at each connection between ponds. It also accounts for the length and elevation of any weir in the system. Flow per unit length over each weir is computed based on a rating curve for a sharp-crested weir (e.g., Chow, 1959). Flow through the culverts is based on rating curves developed using HEC-RAS (Hydrologic Engineering Center-River Analysis System).

Intake pumps are also accounted for in the pond hydraulic computer model. When salinities increase to undesirable levels in the ponds, pumping will increase circulation through the ponds and decrease salinity. The pump criteria used in the model were proposed to ensure that the predicted discharge salinity remains close to Bay salinity. The amount of pumping required depends on the Bay salinity, gravity inflow rates and the net evaporation from the ponds.

3.3.2 South San Francisco Bay Model

This section describes the computer modeling simulation of salinity in the South Bay and associated tidal sloughs. The simulations were performed using a state-of-the-art three-dimensional hydrodynamic model. In order to provide confidence that the three-dimensional hydrodynamic model reliably estimates salinity during existing conditions and during the proposed Initial Stewardship period, a substantial model calibration/validation was performed. First the model was calibrated to accurately simulate observed currents and water surface elevation. After the model was calibrated, it was applied to simulate existing salinity conditions without adjustment of any model parameters. The model results are shown to match available salinity data closely.

In order to estimate salinity increases in tidal slough regions, higher resolution in the Tidal, Residual, Intertidal and Mudflat (TRIM) model is required in the tidal sloughs. Two regions, the Alameda Flood Control Channel and the Alviso Region, which includes Coyote Creek, Guadalupe Slough and Alviso Slough, have been selected by representatives of state and federal agencies as regions of particular interest. As described below, salinity in these regions is simulated on high-resolution grids to provide additional detail and improved accuracy.

The results of the pond model simulation were used as an input to the hydrodynamic models to evaluate potential project impacts on the receiving waters. The description of the hydrodynamic modeling and the results of the models are contained in separate reports and are not included in the ISP.

3.3.3 Simulation Period

The pond hydraulic simulations and hydrodynamic simulations for the South San Francisco Bay and slough areas use tide and weather data as part of the model simulations as described in the previous sections. The exact meteorological and Bay salinity conditions that will exist during Initial Stewardship cannot be predicted. However, the estimated initial release salinity from the ponds is likely to be higher than receiving water salinity due to the existing salinity levels in the ponds and the evaporation expected to occur within the ponds during the Initial Stewardship operations.

To evaluate the proposed ISP operation plan and plan alternatives, the pond and receiving water conditions were modeled for a simulation period of 19 months, to include two summer periods and one winter period. The selected period was from April 1994 through October 1995. The particular period was selected to include a relatively recent period where Bay tidal and salinity profile information was available, and to include a range of meteorological conditions.

The 1994 period was considered suitable because it represents a relatively dry year, with above average salinity in the South Bay. This was considered important to evaluate initial release conditions where local salinity conditions could potentially reach or exceed the maximum salinity tolerance of existing flora and fauna in the Bay or sloughs. The intent was to evaluate initial release and summer operational salinities for a year with above average Bay salinities to identify maximum salinities that may occur. Analysis of the impact of salinity upon the aquatic species was conducted. The results of this evaluation indicate that during the period of the Initial Stewardship, salinities in segments of the Bay and its tributaries are predicted to be elevated, but significant impacts to aquatic life would be unlikely.

Figure 3-1 compares measured average monthly South Bay salinity during 1994 to average South Bay salinity (from 1988 to 2000). Data from the USGS “pilot RMP” station 30 (near the San Mateo Bridge area, close to the existing Baumberg intake). The plot shows the average salinity for each month (triangles) and one standard deviation from the average (error bar). One standard deviation represents a statistical value for the variation from the average value. Approximately 67 percent of all years would fall within one standard deviation, within the error bar on the graph. Approximately 84 percent of all years would have a lower salinity than the top of the error bar. The 1994 monthly salinity values (circles) at station 30 are consistently near the top of the error bar during the spring and summer. Therefore the 1994 year was well above average salinity, and represents a conservative period for the evaluation of maximum salinities in the Bay and sloughs. Figure 3-2 shows similar results for station 36 (near the Dumbarton Bridge area).

The high Bay salinities affect both the salinity levels in the receiving waters, and the operation of the ISP pond systems since the high intake salinities affect the circulation salinities in the ponds and the resulting discharge salinities. This affects both the summer operation conditions in dry years and the potential for initial release during a dry year. If the initial release occurs in a dry year, the higher intake salinities would take longer to dilute the existing higher salinity water in the ponds. The 1994 year was used to evaluate initial release condition for all initial release scenarios.

Figures 3-1 and 3-2 also show the measured salinities for 1995 (squares). The winter of 1995 was a particularly wet winter and the Bay salinities are lower than average. By March, the Bay salinity at station 30 was at the lower end of the error bar. This means that approximately 16 percent of years would have lower average monthly salinities in March. For the remainder of the summer, the 1995 average salinity is below the lower end of the error bar.

The 1995 period was used to model and to evaluate long term ISP operation during wet years with low average salinity in the Bay and sloughs. This was considered to evaluate potential increases in salinity during periods of low salinity. The 1995 period was also included to evaluate operation of the pond systems during wet winters where flood conditions could occur in the ponds. This was included to evaluate whether the ponds could be operated with high rainfalls and not affect the stability or erosion of the existing levees.

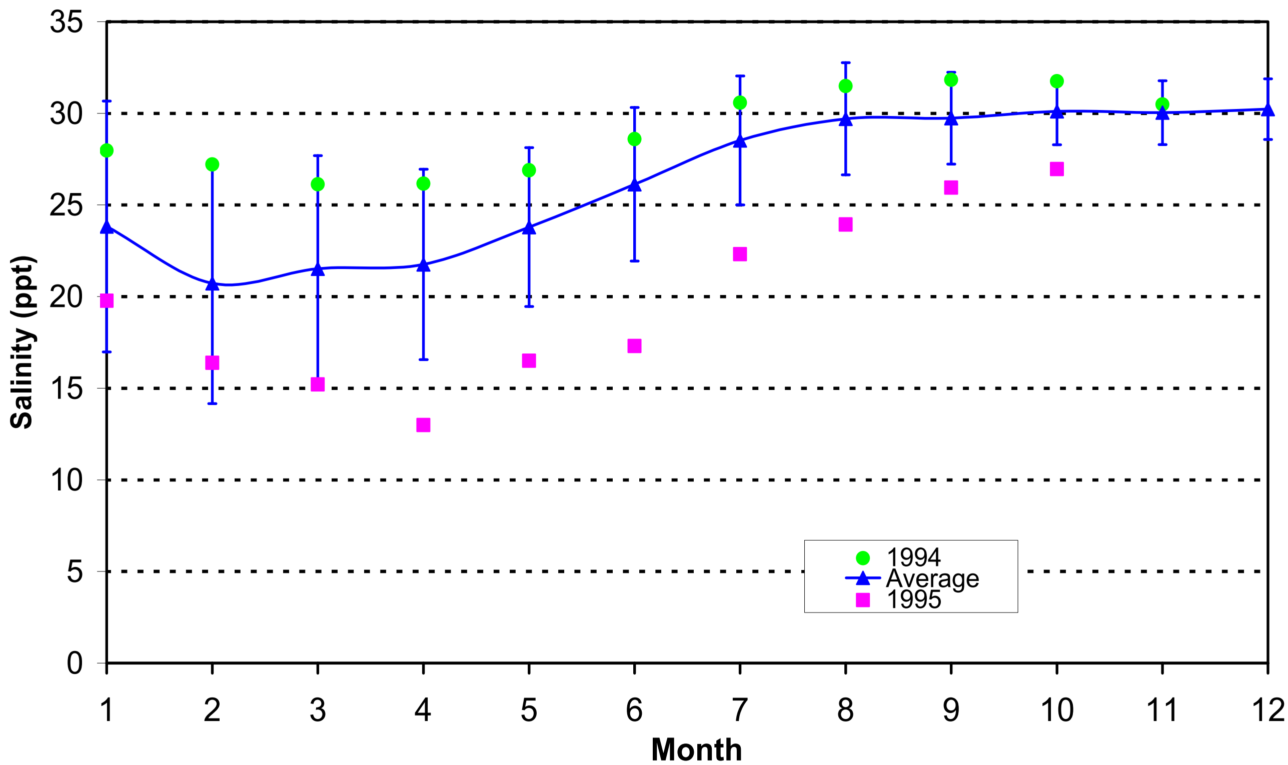


Figure 3-1
Monthly Salinity Averages from Station 30 near the San Mateo Bridge

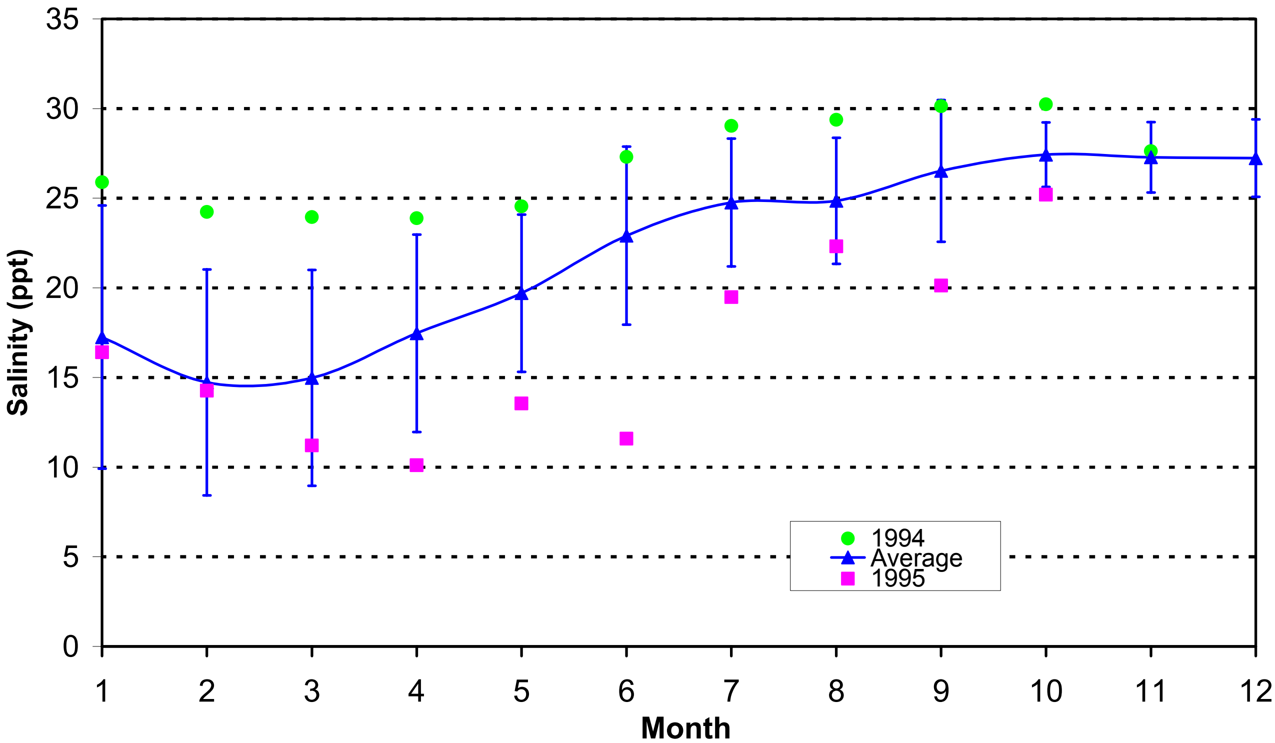


Figure 3-2
Monthly Salinity Averages from Station 36 near the Dumbarton Bridge

3.4 History of Project Design (Alternatives)

This section describes the project alternatives considered in the development of the ISP. These are as follows:

- No Action Alternative
- Maintain Infrastructure Only
- Culvert Structures for Island Ponds A19, A20 and A21
- Seasonal Pond Operations
- Flexibility in Time Period of Initial Release
- Individual System Alternatives

3.4.1 No Action

Under the No Action alternative, there would be no flow circulation through the pond systems. No additional water control structures would be installed, no release of pond contents or management of water and salinity levels would occur, and the existing infrastructure would not be maintained. The contents of the ponds would be allowed to evaporate leaving behind salt-crusted flats and in deeper areas, residual pools of concentrated brine. Ponds would take 1 to 2 years to dry. The deepest portions of the ponds would be seasonally wet during winter, filling with water after rain events. Under the No Action alternative, most of the existing open water habitats currently used by wildlife would be eliminated. Without maintenance pond levees and control structures would be prone to failure, increasing risk of uncontrolled intake and release of flows from/to the Bay. This alternative minimizes additional inputs of salinity and does not require a permit to discharge pond contents into the Bay. Long-term pond drying may result in hyper-saline soil conditions. This may cause the chemistry of the soil to be affected in a manner that would likely increase the cost and level of effort of future restoration.

3.4.2 Maintain Infrastructure Only

This alternative is the same as the No Action alternative except that the levees and water control structures would be maintained and repaired as needed. The ponds would be managed as seasonal ponds until the final restoration plan has been completed. Under this scenario the pond contents would be removed or allowed to evaporate. During the summer, they would be maintained as dry to minimize construction and management costs. During winter they would fill during precipitation events but contents would not be discharged. Maintenance of the levees and water control structures would prevent their deterioration that could cause the accidental breaching of the ponds and release of pond contents to the Bay. Under this alternative, most of the existing open water habitats currently used by wildlife would be eliminated, significantly changing the character of the South Bay salt ponds.

This alternative minimizes additional inputs of salinity and does not require a permit to discharge pond contents into the Bay. As with the No Action alternative, long-term pond drying may result in hyper-saline soil conditions. This may cause the chemistry of the soil to be affected in a manner that would likely increase the cost and level of effort of future restoration.

3.4.3 Culvert Structures for Island Ponds

Under the proposed ISP, the Island Ponds (A19, A20, and A21) would be breeched on the Coyote Creek side to establish full tidal conditions in the ponds. The island ponds ISP conditions are described in Section 4.2. A project alternative for the island ponds would be construct culvert inlet/outlet structures to manage the separate inlet/outlet structure; one for each pond. The ponds would be managed to maintain water levels in the ponds approximately one foot above the average bottom elevation. The culverts would be constructed to connect to either Mud Slough or Coyote Creek. Since the barge access to A19 and A20 would be from Mud Slough, the preferred location would be along Mud Slough. Due to their location between Lower Coyote Creek and Mud Slough, the Island Ponds are fairly inaccessible, and therefore, difficult to actively manage. Also, construction would be both difficult and expensive.

3.4.4 Seasonal Pond Operations

Under the proposed ISP, several pond systems consisting of numerous ponds include one or more pond(s) serving as batch ponds. Due to their location within the systems or due to the pond bottom elevations, the batch ponds were not included in the continuous tidal circulation systems. They would not have a direct hydrologic connection to the Bay or tidal sloughs and creeks, but rely on a neighboring pond for delivery of inflows and release of outflows. The volume and frequency of the intake and release from/to a neighboring pond can be used to control the batch pond salinity and water levels. Bottoms of batch ponds may be high, generally requiring pumping to fill the ponds (Baumberg 12, 13, and 14). For other batch ponds, the pond bottoms may be low, generally requiring pumping to remove water from the ponds (Alviso A8, A12, and A13). Batch ponds can easily be managed for high salinity in the range of 120-150 ppt. to favor brine shrimp and brine fly production, an important food source to certain migratory birds. Batch ponds may be operated as seasonal ponds and filled during the winter and drained during the summer.

Seasonal ponds differ from batch ponds in that their contents would be drained. Seasonal ponds will fill from high groundwater or rain during winter and be allowed to dry-down through the summer. The pond salinity would not be controlled, but would fluctuate due to residual salt in the pond, rainwater inflows, and seasonal evaporation. The major benefits of a seasonal operation are the habitat provided for certain species and the elimination of costly pumping to water to maintain water levels.

3.4.5 Flexibility in Time Period of Initial Release

Under the proposed ISP, structures would be installed in when site constraints allow and initial discharge of the existing pond contents would begin the following March/April when salinities within the ponds and receiving waters are the lowest. Allowing initial release of pond contents into the Bay at other times during the year may be desirable as a contingency if all necessary water control structures cannot be installed prior to March/April release date. Concerns regarding this alternative include the ability to meet regulatory requirements for the initial discharge of pond contents and effects of elevated salinity at discharge locations to salmonids and bay shrimp. Salmonid migration would not be a concern in July or August.

The proposed Phased Release scenario would include initial release of a limited number of ponds in July, with other pond systems to follow in subsequent years. This could allow for a limited number of structures to be constructed in the spring. The phased release scenario is described in more detail in Section 4.3.

3.4.6 Individual System Alternative

Several of the individual systems described in Section 4 have been revised during the development of the ISP. Some of the system alternatives are described below. Note that the systems are named for the pond containing the outflow structure.

3.4.6.1 Alviso A3W System

In the Alviso A3W system, an alternative intake location was considered for the additional intake to pond B1. The alternative location was close to the northern end of the pond near Stevens Creek. The alternative location would avoid existing marsh areas along the Bay levee and was close to the deeper channel maintained by flows from Stevens Creek. The existing intake location has marsh elevations outside the intake which limit inflow to only high tide periods. After consultation with NMFS, Stevens Creek was identified as potential steelhead habitat. The alternative intake location was not included in the ISP to avoid potential conflicts with steelhead migration to and from Stevens Creek.

3.4.6.2 Alviso A7 System

An alternative intake location was considered for the Alviso A7 system intake. The alternative was to intake at the A7 outfall location, and discharge at the A5 intake location. Under the alternative, the system would flow in the reverse direction from the ISP direction. The alternative would avoid potential intake of fresh water from Guadalupe Slough which contains effluent from the Sunnyvale WWTP. The alternative intake location was not included in the ISP to avoid potential conflicts with steelhead migration in Alviso Slough. After consultation with NMFS, Alviso Slough was identified as Chinook salmon and steelhead habitat. Detailed modeling of the Guadalupe Slough conditions has shown that the slough at the A5 intake location would be predominantly higher salinity Bay water at high tide. The gravity intake would flow at high tide.

3.4.6.3 Alviso A14 System

The Alviso A14 system included two separate alternatives which would include continuous circulation through all of the ponds. The ISP includes ponds A12, A13 and A15 as batch ponds.

The first alternative included four separate sub systems. A9 and A14 would be one sub system with flow from A9 to A14. A10 and A11 would be intake/outlet sub systems with tidal inflow and outflow to and from Alviso Slough into each pond. A15, A13 and A12 would be the last sub system with flow from A15 to A12. The alternative included potential issues with multiple discharges to Alviso Slough during initial release. The spring or summer freshwater flow in Alviso Slough may not be sufficient to carry the salinity from the pond discharges out to the Bay during the initial release. In addition, the flow from A15 to A12 would transfer Coyote Creek water to Alviso Slough and could represent a distracting trace flow to upstream migrating salmonids which may follow chemical clues from Coyote Creek.

The second alternative would include all of the ponds in the Alviso A14 system, without sub systems. The inflow would be at A15, the highest pond in the system. The flow would be from A15, through ponds A14, A13, A12, A11, A10 and discharge at A9 to lower Alviso Slough. The alternative would allow gravity flow without the use of the existing pump from A13 up to A15. However, the alternative would reverse the flow of the entire system and would increase operating water levels in ponds A14, A13, and A12, and decrease operating water levels in ponds A9 and A10. The higher water levels in ponds several ponds would require raising several internal levees and the levee along the railroad southeast of ponds A12 and A13.

3.4.6.4 Alviso A16 System

Two alternatives were considered for the Alviso A16 system. The first alternative would reverse the ISP direction of flow to intake from Artesian Slough and discharge to Coyote Creek. The intake from Artesian

Slough would avoid potential entrainment of migrating salmonids in Coyote Creek. However, the intake from Artesian Slough would contain low salinity water from the San Jose WWTP, and the entire system could operate at much lower salinities. The lower pond salinities could increase the risk of avian botulism in the ponds.

The second alternative for the Alviso A16 system would operate ponds A16 and A17 as batch ponds at higher salinities similar to ponds A12, A13 and A15 in the A14 system. This alternative would require a high salinity discharge to either Coyote Creek or Artesian Slough. Evaluation of the predicted pond discharge shows that the high salinity discharge may not meet receiving water quality objectives on a long term basis.

3.4.6.5 Baumberg 2 System

An alternative operation was considered for Baumber 2 system to maintain the water levels in all four ponds on a year around basis. This would require additional pumping at the pond 1 intake and construction of additional pumping capacity. This was not the preferred alternative due to the high cost of pumping during the summer peak evaporation season.

3.4.6.6 Baumberg 2C System

An alternative flow operation was considered for Baumberg 2C system to maintain the existing direction of flow from pond 4C to 5C to 1C. This was not the preferred alternative because the existing Coyote intake pump would be available to supplement the flow from the pond 6 intake pump, and to maintain future flexibility in the system.

3.4.6.7 Baumberg 8A System

An alternative operation was considered for Baumberg 8A system to maintain the water levels in all four ponds on a year around basis. This would require construction of an intake pump into the system. The intake pump was proposed at pond 8A to flow through to pond 9 and discharge at pond 9 to Mount Eden Creek. The flow from 8A to 9 was proposed to follow the existing pond bottom elevations to maintain similar pond depths in the two ponds. This was not the preferred alternative due to the high cost of pumping during the summer peak evaporation season.

3.4.6.8 Baumberg 6A System

An alternative operation was considered for Baumberg 6A system to maintain the water levels in all three ponds on a year around basis. This would require construction of an intake culvert or pump into the pond 8 and a discharge from pond 6A. This was not the preferred alternative due to the potential for higher salinities in Old Alameda Creek during the summer high evaporation season, and the potential for recycling of the discharge from pond 6A to the intakes at ponds 6 and 1. Old Alameda Creek has a limited drainage area with low flow rates in the summer to carry the pond 6A discharge downstream to the Bay.

4.0 Proposed Initial Stewardship Implementation Plan

4.1 General Project Description

4.1.1 Introduction and Summary

The purpose of this ISP is to circulate water through the South Bay salt ponds to minimize any effects on existing potential wildlife habitat, pond water quality and salinity levels during the planning and implementation of a long-term salt pond restoration program. The project includes installation of water control structures, operation of ponds including discharge of waters, and maintaining structures and levees. Following initial release of brines from salt-making operations, the ponds would be operated to generally limit salinity discharge levels to 40 ppt. The proposed discharge limit for long-term operations is 44 ppt to allow some flexibility in the operation of the individual pond systems during the initial stewardship period. The proposed pond operations are based on modeling data and may be modified by adaptive management based on results of wildlife and water quality monitoring data.

Following is a summary description of the model used to calculate predicted salinities and water depths under the ISP, predicted water depths in the ponds, proposed and modeled discharge salinities, and the structures to be installed to meet the project objectives. Detailed project descriptions for the Alviso, Baumberg, and West Bay complexes and their individual pond systems are included in Section 4.2. Section 4.2 also describes the modeled initial release conditions based on April 2002 pond conditions, which was used for design of the project structures and evaluate system constraints. Section 4.3 presents salinity model results for permit conditions under maximum initial release conditions and under phased initial release conditions for those same complexes. The preferred project for CEQA/NEPA evaluation includes the phased initial release scenario in Section 4.3.2.

4.1.2 Overall Hydraulic Design

The proposed hydraulic structures and circulation systems have been designed based on hydraulic modeling of the individual pond systems. The pond hydraulic model described in Section 3.4.1 was used to model initial and long-term conditions in each pond system for the ISP.

The pond model was used to simulate the pond systems for an 18-month period from April 1994 to October 1995. As described in Section 3.3.3, the time period was selected to include two summer evaporations seasons; one for a dry year with high bay salinities; and one for a wet year with low bay salinities.

4.1.3 Initial Salinity Releases

The initial release period is the startup period for the circulation of bay water through the pond systems. By the use of water management techniques developed during years of salt production, the targeted ponds' salinity will be reduced to levels similar to the salinity of the Bay. These water management techniques include the following:

- The use of tides to move water in and out of the various ponds and the Bay
- Careful monitoring of water movement and salinity
- Natural mixing of differential saline solutions
- Replacement of displaced high saline waters with Bay water

In a simplified example, Pond A's outflow structure will be opened to allow tides to discharge waters from the pond into the Bay. At the same time an adjacent pond, Pond B, will be partially drained into Pond A to take the place of the original discharged water. The intake structure to Pond B will also be opened to allow Bay water to enter Pond B. As the tides rise and the flows through the structures slow and cease, some natural mixing of the water will take place in the ponds reducing the salinity in the system slowly in a cost-effective manner.

For project design and to evaluate system constraints, the pond salinities during the initial release period were estimated based on salinity and water levels recorded in April 2002 as a representative time. April was considered a reasonable time for the initial release because bay salinities are generally low to maximize dilution of the higher initial release salinities within the ponds before discharge and in the receiving waters after discharge. Also, April is the beginning of the summer high evaporation season, before the salinity levels in the ponds start to increase.

The April 2002 initial release salinities were used in conjunction with recorded bay salinities, freshwater flows and evaporation rates for 1994 and 1995 to model a trial initial release scenario to begin the pond model for the long term conditions for each system. The actual pond salinities may vary as shown in the historic range of salinity in the individual ponds included in Table 4.1.5. Therefore, for permitting purposes, maximum initial salinity discharge levels were also modeled using two different release dates: April and July (see Section 4.1.5).

4.1.4 Pond Model Results

The pond model results for the April 2002 initial condition and long term model for each individual pond system are included in the system descriptions in Section 4.2. The model results are presented as graphs of significant hydraulic parameters over time for the model period of April 1994 to October 1995. In Section 4.3 the results of the two other release scenarios are displayed. These permit release scenarios include proposed maximum initial release salinity levels, as described in Section 4.1.

As an example illustrating the contents of the graphs, Figure 4-2 shows the model results for Alviso System A2W. The lower axis is the time within the model period. The left axis is the estimated discharge salinity from the outlet pond over time. For system A2W, using April 2002 pond salinity values, the initial salinity begins at approximately 31 parts per thousand (ppt). The discharge salinity decreases slightly during the first 2 months of the initial release then starts to increase as the summer evaporation increases. The pond salinity decreases in the fall and winter and increases the following summer.

The upper graph in Figure 4-2 also shows the gravity intake flow as a daily inflow volume in acre-feet, using the right axis of the graph. The daily inflow volume fluctuates with the tide cycle. The inflow is described as a gravity intake to distinguish the flow from a pump intake system. Other systems include pumped inflows. The gravity inflow is flow through a culvert with a flapgate (one way valve). The culvert would allow flow into the pond when the tide elevation outside the levee is above the water level in the pond. The flow graph also shows a discharge flow rate, also expressed as a daily volume in acre-feet. All of the discharge structures in the ISP systems would be gravity flow culverts that would discharge when the tide levels are lower than the water level in the discharge pond.

The lower graph in Figure 4-2 shows the same discharge salinity as the upper graph, with the calculated water levels in the intake pond and outlet pond. For system A2W, pond A1 is the intake pond and pond A2W is the outlet ponds. All of the systems are labeled based on the pond designation for the discharge pond. Therefore each discharge has a unique name and is associated with an individual system. For system A2W, the water levels in the intake pond A1 are always higher than the water level in the discharge pond A2W. Water flows from A1 to A2W by gravity.

4.1.5 Maximum Initial Release Salinities

Although the initial modeling utilized actual pond salinities from April 2002 for trial initial release conditions, those salinities are not static. Because of the variability of salinity conditions within the pond systems, an upper limit for the initial release salinity conditions is proposed. The upper limits for the initial salinities provide an upper bound for the initial release conditions for the discharge permit and CEQA/NEPA evaluation. These upper limits are presented in Table 4.1.5 and the simulation results of the pond systems are shown in Section 4.3.

Three pond groupings are proposed based on the maximum salinity that could be discharged. Note that not all ponds would directly discharge to the Bay or sloughs, but Table 4.1.5 lists the maximum salinity of each pond at the time discharge would occur. Ponds were designated for a particular salinity group based on the historic operation of the salt pond and system constraints on changes to the existing salinities. Salinity group 1 ponds would have a maximum initial discharge salinity of 65 ppt. These ponds are generally intake ponds or ponds near intakes with the lowest existing and historic salinities. Salinity group 2 ponds would have a maximum initial discharge salinity of 100 ppt except for Ponds A5, A7, and A8. Salinity Group 2 ponds are in the middle range of the ponds in the proposed initial stewardship project. Salinity group 3 ponds would have a maximum initial discharge salinity of 135 ppt. Additional model results of these maximum salinity release conditions are shown in Section 4.3.

The upper limit for the salinity group 3 ponds was established based on the ion balance in the salt water in the ponds. Sea water or bay water includes a variety of anions and cations, not just sodium and chloride ions. Above approximately 150 ppt, the first ions from the salt water begin to precipitate (calcium sulfate). Below that salinity the pond contents are concentrated bay water and could be diluted back to bay water concentrations without affecting the ratio of the ions in the water. Once some of the ions have precipitated out, the ion balance is affected and the relative concentration of sodium and calcium ions has been changed. This may affect species in the bay or sloughs if the brines were released. Unlike sodium chloride, the calcium sulfate (gypsum) cannot be readily dissolved by exposure to new freshwater. The proposed initial release from Alviso Ponds A19, A20, and A21 (Island Ponds) and West Bay Ponds 1-5 and SF2, which presently contain brines above 150 ppt, would occur after these 150 ppt brines were moved out of these ponds to the salt plant site and replaced with brines/waters that are less than 150 ppt.

Table 4.1.5
Salinity Groups

Salinity Group	Maximum Discharge Salinity	Alviso Complex Ponds	Baumberg Complex Ponds	West Bay Complex Ponds
Group 1	65 ppt	A1, A2W A2E, B1, B2, A3W, A3N	1,2,4,7 10,11	
Group 2	100 ppt	A5*, A7*, A8* A9, A10, A11, A14	5, 6, 1C, 2C, 3C, 4C, 5C, 6C	
Group 3	135 ppt	A12, A13, A15 A16, A17 A19, A20, A21	6A,6B 9,8A,8 12,13,14	1,2,3,4,5,5S SF2

* These ponds include an upper limit of 110 ppt

As noted previously, the model analyses for system design included trial initial release conditions and assumed that all of the continuous circulation ponds would have initial salinity and water surface elevations similar to the recorded conditions in April 2002. The Alviso Island ponds, Alviso ponds A22 and A23, and the West Bay complex ponds were not included in this initial release model analysis. Due to constraints associated with the existing salt operations and agreements between Cargill and DFG/FWS, circulation and discharge of waters from these ponds would be at a later time than the other ponds.

For CEQA/NEPA evaluation and discharge permitting, two permitting initial release scenarios were developed using the pond model described above and in Chapter 3. The results of the pond model for the permitting initial release scenarios are included in Section 4.3.

The modeled initial release scenarios are:

- **April 2002 Initial Salinity** - All systems except the island ponds (A19, A20, and A21), the A23 system, and the West Bay pond group to begin discharge in April. Initial pond salinities based on recorded values from April 2002.

- **Maximum Initial Salinity** - All systems except the island ponds (A19, A20, and A21), the A23 system, and the West Bay pond group to begin discharge in April. Initial pond salinities based on the maximum salinities from Table 4.1.5 above.

- **Phased Release, with Maximum Initial Salinity** - Selected ponds would begin initial release at the same time. These would include Alviso Systems A2W, A3W, A7 and Baumberg Systems 2, 8A and 11. The ponds were selected to represent a significant number of systems that could be included in a first phase of the project based on construction and operational constraints. The phased release was assumed to begin in July, to allow some construction in the spring after the winter rainy season. Most of the proposed system structures would not be accessible for construction during the winter. The initial pond salinities were based on the maximum salinities from Table 4.1.5 above. The remaining pond systems, Alviso Systems A14 and A16, and Baumberg System 2C, would start circulation in the subsequent year. The initial release for these later systems is proposed to occur the following April and the model results would be similar to the Maximum Initial Salinity scenario above.

The phased release scenario also included a modification of the operation for Baumberg System 11. Because the phased release would occur prior to completion of the Mount Eden Creek channel construction project, the proposed outlets to the new channel from ponds 10 and 11 would not be available for the phased release scenario. An alternative initial operation scheme was included which would use the existing pond 10 intake as an intake/outlet. The initial release would be from the intake and would release the volume of ponds 10 and 11. After the initial release, pond 11 would be operated as seasonal with no intake or discharge. Pond 11 would partially fill with rainwater during the winter and dry out during the summer.

The results of the simulation modeling for the April 2002 Initial Salinity scenario are presented in Section 4.2. The results for the Maximum Initial Salinity and the Phased Release scenarios are presented in Section 4.3. These proposed permitting initial release scenarios would not affect the modeled long-term operation results described in Section 4.2.

4.1.6 Long Term Discharge Salinities

The water control structures were designed to maintain discharge levels below 40 ppt year round. However, to anticipate potential operational issues that could occur during ISP operations, the possibility of salinity peaks up to 44 ppt were evaluated and will be included in the EIR/EIS for this project.

4.1.7 Summary of Water Surface Elevations

The existing average pond water surface elevations were based on recorded values for the past 6 years, January 1997 to December 2002. A summary of existing pond salinities, existing water surface elevations and predicted ISP conditions is shown on Table 4.1.7.

Table 4.1.7
Pond Elevations under Existing and ISP Conditions and Salinity under Existing Conditions

Pond	Pond Area (Acres)	Pond Bottom Elevation NGVD	Existing Average (Year Round) Depth (ft)	Salinity Range (ppt)	Summer					Winter				
					Existing			ISP	Change (ISP-Avg) (ft)	Existing			ISP	Change (ISP-Avg) (ft)
					6-year Average Depth (ft)	Depth Range		Avg Water Depth (ft)		6-year Average Depth (ft)	Depth Range		Avg Water Depth (ft)	
						Min (ft)	Max (ft)				Min (ft)	Max (ft)		
Alviso Ponds														
A1	277	-1.8	1.8	11-42	1.8	1.3	2.5	1.4	-0.4	1.8	1.4	2.8	1.7	-0.2
A2W	429	-2.4	1.8	15-43	1.8	1.1	2.6	1.9	0.2	1.8	1.3	2.8	2.2	0.4
B1	142	-0.8	1.5	13-41	1.4	0.7	2.2	1.2	-0.1	1.6	1.0	2.4	1.7	0.0
B2	170	-0.6	1.3	13-43	1.2	0.5	2.0	1.0	-0.1	1.4	0.8	2.2	1.5	0.0
A2E	310	-3.1	1.9	18-43	2.0	1.1	2.7	2.6	0.7	1.9	1.3	2.8	3.1	1.2
A3N	163	-1.4	0.6	16-41	0.8	0.0	1.2	**B/S**		0.6	-0.1	1.3	**B/S**	
A3W	560	-3.2	1.9	23-44	1.9	1.1	2.6	1.8	-0.1	2.0	1.3	2.9	2.1	0.2
A5	615	-0.6	0.7	28-60	0.7	0.2	1.1	1.0	0.3	0.8	0.1	1.2	1.2	0.4
A7	256	-0.5	0.6	28-75	0.5	0.0	0.9	0.9	0.4	0.7	-0.1	1.1	1.1	0.5
A8	406	-3.4	1.6	31-110	1.4	0.6	2.2	**B/S**		1.8	1.2	3.3	**B/S**	
A9	385	-0.2	4.1	11-38	4.1	3.5	4.7	2.2	-1.9	4.1	3.2	5.1	1.7	-2.3
A10	249	-0.8	3.3	17-45	3.3	2.8	4.0	2.6	-0.7	3.4	2.6	4.5	2.3	-1.1
A11	263	-1.8	3.5	28-69	3.3	2.5	4.3	3.1	-0.1	3.6	2.9	4.6	3.2	-0.4
A14	341	0.0	1.4	48-135	0.8	0.1	2.0	0.9	0.1	1.5	0.5	2.5	1.3	-0.3
A12	309	-2	3.4	35-66	3.1	2.3	4.2	**B**		3.7	2.5	4.6	**B**	
A13	269	-1.1	2.3	38-77	2.0	1.2	3.2	**B**		2.7	1.6	3.6	**B**	
A15	249	0.7	2.2	40-111	2.1	0.8	2.7	**B**		2.3	1.6	3.0	**B**	
A17	131	1.1	1.6	45-137	1.4	0.6	2.5	1.2	-0.3	1.8	1.3	2.7	1.1	-0.7
A16	243	0.6	2.1	43-122	1.9	1.0	2.8	1.7	-0.2	2.3	1.7	3.2	1.6	-0.7
A19	265	1.8	2.0	79-290	2.0	-0.2	2.9	**T**		2.1	1.1	3.0	**T**	
A20	63	1.8	1.9	87-289	1.7	0.4	2.6	**T**		2.0	1.2	3.1	**T**	
A21	147	2.31	1.2	87-304	1.0	-0.1	2.0	**T**		1.5	0.5	2.5	**T**	

Notes: S = Seasonal Pond
B = Batch Pond
T = Tidal Pond

Table 4.1.7
Pond Elevations under Existing and ISP Conditions and Salinity under Existing Conditions (Continued)

Pond	Pond Area (Acres)	Pond Bottom Elevation NGVD	Existing Average (Year Round) Depth (ft)	Existing Salinity Range (ppt)	Summer					Winter				
					Existing			ISP	Change (ISP-Avg) (ft)	Existing			ISP	Change (ISP-Avg) (ft)
					6-year Average Depth (ft)	Depth Range		Avg Water Depth (ft)		6-year Average Depth (ft)	Depth Range		Avg Water Depth (ft)	
						Min (ft)	Max (ft)				Min (ft)	Max (ft)		
Baumberg Ponds														
1	337	2.2	2.6	18-46	2.5	1.9	3.4	1.3	-1.2	2.8	2.3	3.8	2.3	-0.5
7	209	2.5	2.3	23-59	2.2	1.5	3.0	0.6	-1.6	2.5	2.0	3.5	1.9	-0.6
4	175	2.9	1.5	16-60	1.4	0.7	2.3	0.2	-1.2	1.6	0.9	2.7	1.5	-0.2
2	673	2.1	2.7	20-49	2.5	1.9	3.4	1.0	-1.6	2.9	2.3	3.9	2.3	-0.6
6	176	2.4	2.3	25-148	2.1	1.4	2.7	2.8	0.7	2.5	1.8	3.6	2.5	0.1
5	159	2.4	2.2	23-149	2.0	1.5	2.6	2.7	0.8	2.3	1.5	3.5	2.5	0.2
6C	78	2.8	1.7	23-132	1.5	1.0	2.1	2.2	0.7	1.8	1.1	2.9	2.1	0.3
4C	175	3.2	1.0	23-143	0.8	0.5	1.8	1.3	0.5	1.3	0.5	2.5	1.6	0.3
3C	153	2.9	1.3	23-145	1.1	0.7	2.1	1.1	0.0	1.6	0.7	2.8	1.7	0.1
1C	66	3.6	0.6	22-147	0.5	0.2	1.3	0.9	0.4	0.1	0.2	2.1	1.2	1.1
5C	111	3.4	0.8	20-136	0.6	0.3	1.5	1.1	0.5	1.1	0.3	2.3	1.4	0.3
2C	24	2.7	1.3	20-178	1.0	0.5	1.8	1.3	0.3	1.6	0.7	2.7	1.7	0.1
8	180	3.7	2.5	48-296	2.8	1.3	2.8	**S**		2.8	2.3	3.3	0.6	-2.2
6B	284	2.1	0.9	35-231	0.6	-0.6	2.0	**S**		1.2	0.6	2.7	0.9	-0.3
6A	340	0.9	2.2	32-184	1.9	1.1	3.2	**S**		2.4	1.8	4.0	2.1	-0.3
9	366	2.6	2.1	62-241	1.8	1.1	3.0	0.8	-1.0	2.4	1.8	3.3	2.0	-0.4
8A	256	4.0	0.7	69-265	0.4	-0.5	1.6	-2.0	-2.3	1.0	0.4	1.9	0.6	-0.4
12	99	2.9	1.7	27-328	1.4	0.1	2.7	**S**		1.9	1.5	2.9	1.1	-0.8
13	132	3.1	1.5	27-334	1.2	-0.1	2.5	**S**		1.7	1.2	2.6	0.9	-0.8
14	156	3.5	1.2	32-304	0.9	0.1	2.1	**S**		1.4	0.9	2.2	0.5	-0.9
10	214	2.4	1.3	16-74	1.3	0.3	1.6	1.2	-0.1	1.4	0.3	2.6	1.6	0.1
11	118	2.9	1.4	16-81	1.3	0.4	1.8	**S**		1.6	0.4	2.6	1.1	-0.5

Notes: S = Seasonal Pond
B = Batch Pond

Table 4.1.7
Pond Elevations under Existing and ISP Conditions and Salinity under Existing Conditions (Concluded)

Pond	Pond Area (Acres)	Pond Bottom Elevation NGVD	Existing Average (Year Round) Depth (ft)	Existing Salinity Range (ppt)	Summer					Winter				
					Existing			ISP	Change (ISP-Avg) (ft)	Existing			ISP	Change (ISP-Avg) (ft)
					6-year Average Depth (ft)	Depth Range		Avg Water Depth (ft)		6-year Average Depth (ft)	Depth Range		Avg Water Depth (ft)	
						Min (ft)	Max (ft)				Min (ft)	Max (ft)		
West Bay Ponds														
1	445	2.1	0.5	35-326	0.4	-2.0	2.9	0.9	0.5	0.8	-2.0	3.1	1.0	0.2
2	145	2.0	1.6	64-306	1.4	0.1	2.9	0.8	-0.6	1.7	0.2	3.4	0.9	-0.8
3	273	2.2	1.2	145-320	0.9	-0.4	2.4	0.8	-0.1	1.6	-0.4	2.7	0.9	-0.8
4	297	2.8	0.4	88-341	0.0	-1.8	1.5	0.7	0.6	0.7	-1.8	2.0	0.7	0.0
5	31	2.5	0.6	96-340	0.3	-1.6	1.7	1.0	0.7	1.0	-1.6	2.2	1.0	0.0
S5	29	2.5	-2.5					1.2					1.2	
SF2	242	2.6	1.0	76-316	1.0	0.3	2.1	0.7	-0.3	1.0	0.2	2.2	0.8	-0.2

Notes: S = Seasonal Pond
B = Batch Pond

4.1.8 Water Control Structures

The intake and outlet structures and internal connections were designed to provide adequate circulation and water quality control during the summer evaporation season. Tables 4.1.8 a, b, c, and d summarize existing and proposed water control structures for each pond system. Intake and outlet structures were sized to maintain discharge salinity levels below 40 ppt. for a summer after a low rainfall winter. Intake and outlet structures are designed with operable gates and flapgates to control water level.

Predicted flow rates for each system are described using average daily flow and peak flows for both the intake and outlet. During summer, the intake flows generally exceed the discharge flows due to the evaporation from the pond system. During winter, intake flows are less than discharge flows due to rainfall into the pond system.

Some control structures were designed to allow the ability to close off all flow, allow inflow only, or allow outflow only, offering the management ability to reverse direction of inflow and outflows when necessary to control salinity and/or water levels. In Alviso System A3W and Baumberg Systems B2 and 8A, under flood conditions, it may be necessary to use the intake as an outlet to drain excess volume from the system to prevent wave wash from excessive high water from damaging levees. In Alviso System A16, flows can be reversed to avoid inflows from San Jose Waste Water Treatment Facility. Intake flows in Alviso system A9 and A16 can be blocked or reversed during the winter to prevent entrainment of migrating salmonids. Because of the flapgates and the relative elevations of the tide and pond water levels, all intake flow would occur at high tide, and all outflows would occur at low tide.

Table 4.1.8a
Water Control Structures
Alviso

Structure Number	From	To	Type	Structure	new/existing
Alviso A2W System					
A2W-1-inlet	Charleston	A1	Gravity	60" gate	existing
A2W-2	A1	A2W	Gravity	72" siphon	existing
A2W-3	A2W	A2E	Gravity	siphon to A2E (A3W System)	existing
A2W-4-outlet	A2W	Bay	Gravity	48" gate	new
Alviso A3W System					
A3W-1-inlet	Bay	B1	Gravity	48" gate	new
A3W-2-inlet	Bay	B1	Gravity	36" gate	existing
A3W-3	B1	B2	Gravity	60' Gap	existing
A3W-4	B1	A2E	Gravity	48"gate	new
A3W-5	A2W	A2E	Gravity	siphon from A2W (A2W System)	
A3W-6	A2E	A3W	Gravity	2-36" pipes in series	existing
A3W-7	B2	A3W	Gravity	36" gate	replace A3w-7x
A3W-7x	B2	A3W	Gravity	24" gate	remove
A3W-8	B2	A3N	Batch	24" gate	existing
A3W-9	A3N	A3W	Batch	24" gate	existing
A3W-10-outlet	A3W	Guadalupe	Gravity	3x48" gates	new
Alviso A7 System					
A7-1-inlet	guadalupe	A5	Gravity	2 x 48" gates	new
A7-2	A5	A7	Gravity	12' cut	new
A7-3	A5	A7	Gravity	gap	fill existing gap
A7-4	A7	A8	Gravity	24" gate	existing
A7-5	A4	A5	Gravity	siphon from A4	existing
A7-6	A8	A11	Pump	4,000 gpm pump to A11/A7	new piping from existing pump
A7-7-outlet	A7	alviso	Gravity	2 x 48" gates	new
A7-8	guadalupe	A8	Gravity	overflow weir	new by others

Table 4.1.8a
Water Control Structures
Alviso
(Continued)

Structure Number	From	To	Type	Structure	new/existing
Alviso A14 System					
A14-1-inlet	alviso slough	A9	Gravity	2 x 48" gates	existing
A14-2	A9	A10	Gravity	48" gate	remove & replace
A14-3	A10	A11	Gravity	48" gate	existing
A14-4	A11	A12	Batch	48" gate	existing
A14-5	A12	A13	Batch	48" gate	remove & replace
A14-6	A15	A16	Batch	30" siphon to A16	existing
A14-7	A11	A14	Gravity	48" gate	new
A14-8	A14	A13	Batch	36" gate	existing
A14-9	A13	A15	Pump	22k gpm pump to A15	existing
A14-10-intake	coyote crk	A15	Alt Intake	48" gate	new
A14-11	A15	A14	Batch	36" gate	repair by others
A14-12	A9	A14	Gravity	36" gate	new by others
A14-outlet	A14	coyote ck	Gravity	2 x 48" gates	new
Alviso A16 System					
A16-1-inlet	coyote crk	A17	Gravity	48" gate	new
A16-2	A17	A18	Gravity	30" siphon w/gate to A18	existing
A16-3	A17	A16	Gravity	50' cut	existing
A16-4	A15	A16	Gravity	30" siphon w/gate from A15	existing
A16-5-outlet	A16	artesian slough	Gravity	48" gate	new
Alviso A23 System					
A23-1-intake	mud slough	A22	Gravity	48" gate	new
A23-2	A22	A23	Gravity	wood box	existing
A23-3-intake	mud slough	A23	Gravity	48" gate	new
A23-4	A22	A23	Gravity	24" gate at pump station	existing
A23-5	A23	A22	Gravity	24" gate at pump station	existing
A23-6	A23	Plant 2 CP4/CP5	Gravity	4000 gpm Crabby Joe Pump	existing

Table 4.1.8a
Water Control Structures
Alviso
(Concluded)

Structure Number	From	To	Type	Structure	new/existing
Island Ponds					
IP-1	A18	A19	Gravity	siphon from A18	existing
IP-2	A18	A19	Gravity	Coyote siphon pump	existing
IP-3	A19	A20	Gravity	siphon	existing
IP-4	A20	A21	Gravity	siphon	existing
IP-5	A21	mud slough pump	Gravity	24" gate	existing
IP-6	A21	plant 2	Pump	Mud Slough pump to Plant 2	existing

Table 4.1.8b
Water Control Structures
Baumberg

Structure Number	From	To	Type	Structure	new/existing
Baumberg 2 System					
B2-1-inlet	old alameda creek	1	Gravity	4 x 48" gates	new
B2-2	old alameda creek	1	Pump	30,000 gpm pump	existing
B2-3	1	2	Gravity	48" gate	replaces B2-3x
B2-3x	1	2	Gravity	8 x 42" wood gates	remove
B2-5	1	2	Gravity	fill existing gap	Fill
B2-6	1	7	Gravity	48" gate	new
B2-7	7	6	Gravity	48" gate to 6	remove
B2-8	7	4	Gravity	25' gap	existing
B2-9	4	5	Gravity	3 x 42" wood gates to 5	remove
B2-10	4	2	Gravity	40' gap	existing
B2-11-outlet	2	bay	Gravity	2 x 48" gates	new
B2-12	na	na	na	raise levee 4/5 & 7/6	raise existing

Table 4.1.8b
Water Control Structures
Baumberg
(Continued)

Structure Number	From	To	Type	Structure	new/existing
Baumberg 2c System					
B2c-1-inlet	continental	6	Gravity	36" siphon from continental (System 6A)	
B2c-2-inlet	old alameda creek	6	Pump	30,000 gpm pump	new
B2c-3	6	5	Gravity	15' gap	replace B2c-3x
B2c-3x	6	5	Gravity	4 x 45" wood gates	remove
B2c-4	5	6C	Gravity	48" gate	replace B2c-4x
B2c-4x	5	6C	Gravity	45" wood gate	remove
B2c-5	5	6C	Gravity	48" gate	replace B2c-5x
B2c-5x	5	6C	Gravity	36" gate	remove
B2c-6	7	6	Gravity	48" gate from 7	remove
B2c-7	4	5	Gravity	3X42" wood gates from 4	remove
B2c-8	6C	4C	Gravity	2 x 30" pipes	existing
B2c-9	1C	5C	Gravity	25' cut	existing
B2c-10	5C	4C	Gravity	25' gap	existing
B2c-11	4C	3C	Gravity	2 x 30" wood gates	existing
B2c-12	3C	2C	Gravity	25' cut w/bridge	existing
B2c-13	1C	5C	Gravity	24" pipe	existing
B2c-14	2C	alameda fcc	Gravity	2 x 48" gates	new
B2c-15	2C	1C	Gravity	30" Pipe	existing
B2c-16-inlet	alameda fcc	1C	Pump	7,660 gpm pump	existing
B2c-17-outlet	2C	Plant 1A	pump	Cal Hill transfer	existing

Table 4.1.1.3b
Water Control Structures
Baumberg
(Continued)

Structure Number	From	To	Type	Structure	new/existing
Baumberg 6a System					
B6a-1-inlet	North Ck	8	Gravity	48" gate	new by others
B6a-2	8	6b	Gravity	24" gate	remove & replace
B6a-3	6B	6A	Gravity	6" wood box	existing
B6a-4	Donut 2	6B	Gravity	36" gate	existing
B6a-5	Donut 2	8	Pump	continental pump	existing
B6a-6	Donut 1	8	Gravity	36" gate	existing
B6a-7	Donut 1	6	Gravity	36" siphon to 6	existing
B6a-8	Donut 1	6a	Gravity	36" gate	existing
B6a-9	Donut 1	Donut2	Gravity	36" gate	existing
B6a-10	6A	old alameda crk	Gravity	48" gate	new
Baumberg 8a System					
B8a-1-inlet	mt eden ck	9	Gravity	4 x 48" gates	new
B8a-2	14	9	Gravity	2 x 58" wood gates	existing
B8a-3	13	14	Gravity	2 x 42" wood gates	existing
B8a-4	Brine Ditch	12/13	Pump	10,000 gpm brine pump	existing
B8a-5	14	8x	Gravity	2 x 42" wood gates	existing
B8a-6	Brine Ditch	Brine Ditch	Gravity	2 x 42" wood gates	existing
B8a-7-inlet	north ck	8x	Gravity	48" pipe	existing
B8a-8	9	8A	Gravity	48" gate	existing w/ new weir
B8a-9	9	8A	Gravity	42" pipe	existing w/ new weir
B8a-10	north ck	8A	Gravity	48" gate	new by others
B8a-11	13	12	Gravity	cross levee abandoned	existing
B8a-12-outlet	8A	old alameda ck	Gravity	48" gate	new

Table 4.1.8b
Water Control Structures
Baumberg
(Concluded)

Structure Number	From	To	Type	Structure	new/existing
Baumberg 11 System					
B11-1-intake	new mt eden ck channel	10	Gravity	4 x 48" gates	new
B-11-2	10	11	Gravity	2 x 43" wood gates	existing
B-11-3	11	new mt eden ck channel	Gravity	48" gate	new by others
B-11-4	10	11	Gravity	48" gate	new by others
B-11-5	10	new mt eden ck channel	Gravity	48" gate	new by others
B11-6	bay	10	Gravity	4 x 48" gates	remove

Table 4.1.8c
Water Control Structures
West Bay

Structure Number	From	To	Type	Structure	new/existing
West Bay Ponds					
WB-1-inlet	ravenswood slough	1	Gravity	2 x 60" gates	existing
WB-1a-inlet/outlet	ravenswood slough	1	Gravity	48" gate	new
WB-2-inlet/outlet	ravenswood slough	3	Gravity	2 x 48" gates	new
WB-3	1	3 or 4	Pump	Ravenswood pump from 1	existing
WB-4-inlet/outlet	ravenswood slough	2	Gravity	2 x 48" gates	new
WB-5	2	1	Gravity	2 x 42" wood gates	existing
WB-6-inlet/outlet	bay	SF2	Gravity	3 x 48" gates	new
WB-7	2	SF2	Gravity	36" siphon	existing
WB-8	3	2	Gravity	30" siphon	existing
WB-9	3	S5	Gravity	36" wood gate	existing
WB-10	5	4	Gravity	existing gap	existing
WB-11-inlet	flood slough	S5	Gravity	48" gate	new
WB-12	S5	5	Gravity	2 x 36" wood gates	existing
WB-13-inlet/outlet	bay	4	Gravity	3 x 48" gates	new

4.1.9 Maintenance

Two types of maintenance would occur for all systems. The first would be normal inspection and maintenance of the gates, culverts, pumps and internal siphon structures throughout the year. The second would be long-term maintenance of the existing levees. Normal inspection and maintenance would occur monthly at the intake, outlet, and siphon to check that the gates and facilities are intact and operable. Gates, valve and siphon would require periodic operation and lubrication. Any damaged or inoperable equipment would be repaired as required.

Long-term maintenance of the levees would be required to compensate for subsidence and erosion. Because the existing levees were constructed from bay mud, the material shrinks and settles over time. It is anticipated that the on-going level of levee maintenance would continue in the future. There is an existing maintenance permit in place that is being transferred to the DFG/FWS.

More details of maintenance, including maintenance based upon monitoring, are included in Chapter 5.

4.2. Detailed Description Pond Complex Operations

4.2.1 Alviso System A2W

System A2W will consist of two ponds, A1 (intake) and A2W (outlet) as shown in Figure 4-1. The objectives for the system include:

- Establish tidal circulation through ponds A1 and A2W
- Maintain water surface elevations close to existing levels
- Maintain long term discharge salinity levels below 40 ppt
- Allow ability for one directional flow or close off all flow at intakes and outlet
- Locate outlet to minimize disturbance to tidal marsh and mudflat outboard of pond A2W.

The proposed system would include the following structures:

- Existing 60” gate intake at A1from lower Charleston Slough
- Existing 72” siphon under Mountain View Slough between A1 and A2W
- Existing staff gage at A1
- New 48” gate outlet structure at A2W to the Bay
- New staff gage at A2W

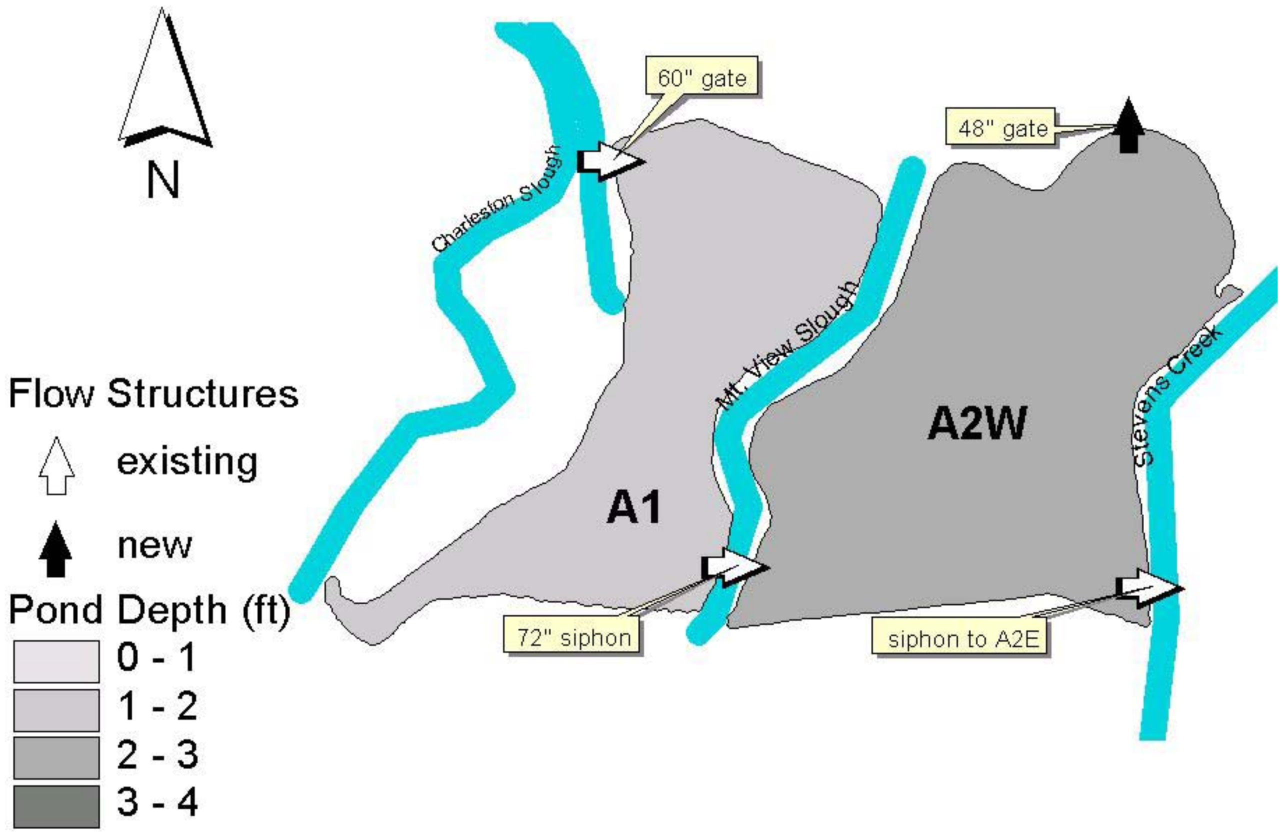


Figure 4-1
Map of Alviso A2W Inflow and Outflow Locations

4.2.1.1 Circulation Hydraulics

The intake location at the northwesterly end of A1 was selected to utilize the existing intake, as well as to allow inflow from lower Charleston Slough. The high tide salinities near the bay would be closer to normal bay salinity than farther upstream. The bay salinity would be closer to existing conditions in the ponds.

The outlet location at the northerly end of A2W was selected to allow outflow directly into the bay. The specific location of the outlet was selected because the mudflat and tidal marsh communities outside the levee are narrowest at the proposed location. However, the rate of discharge from A2W into the Bay may be limited by the elevations of mudflat/marsh area in the vicinity.

4.2.1.2 Interim Management Conditions

The system structure location map and graphs of pond operation flows, water levels and discharge salinities for the Alviso System A2W are shown in Figures 4-1 and 4-2.

The projected summer and winter daily flow and peak flow rates are shown in Table 4.2.1.2.1 below.

Table 4.2.1.2.1
Alviso System A2W Inflow and Outflow

Period	Gravity Intake Flow		Outlet Flow	
	Average	Peak	Average	Peak
Summer May - October	19 cfs 8,400 gpm	44 cfs 20,000 gpm	14 cfs 6,100 gpm	58 cfs 26,000 gpm
Winter November - April	18 cfs 8,200 gpm	44 cfs 20,000 gpm	19 cfs 8,700 gpm	100 cfs 45,000 gpm

The predicted water surface elevations during the initial stewardship period are shown in Table 4.2.1.2.2.

Table 4.2.1.2.2
Alviso System A2W Water Surface Elevations

Pond	Area (acres)	Bottom Elevation (ft NGVD)	Water Elevation (ft NGVD)		
			Existing	Initial Stewardship	
				Summer	Winter
A1	277	-1.8	0.0	-0.4	-0.1
A2W	429	-2.4	-0.6	-0.5	-0.2
Total/ Average	706	-2.2	-0.3	-0.4	-0.2

The control gate settings were not adjusted to actively manage the pond water levels. Active management of the control gate settings could maintain a more uniform water surface elevation in the ponds if necessary. For instance, the winter values shown are for a particularly wet (El Nino) winter and maximum pond elevations in A1 and A2W reached -0.2 ft NGVD, almost half a foot above the 5-year average for these ponds. However, the pond water levels normally vary due to operational considerations and climatic conditions. A1 and A2W have exceeded elevation 0.4 ft during 3 of the past 5 winters.

Although the ISP operation would allow tidal circulation through the pond system, the flow into and out of the ponds on a daily basis would be relatively small compared to the volume in the ponds. Typical daily water surface elevations would fluctuate by less than 0.1 ft.

4.2.1.3 Salinity

The estimated discharge salinity from pond A2W for long term operation conditions is shown in Figure 4-2. The model results are shown for the entire simulation period from April 1994 to October 1995. The model simulation period includes a dry year and a wet year to evaluate discharge salinities for a range of summer operation conditions.

The initial pond salinities and water surface elevations were based on measured conditions in early April 2002. The pond system transitions from the initial starting conditions in the first 4 to 6 weeks of operation.

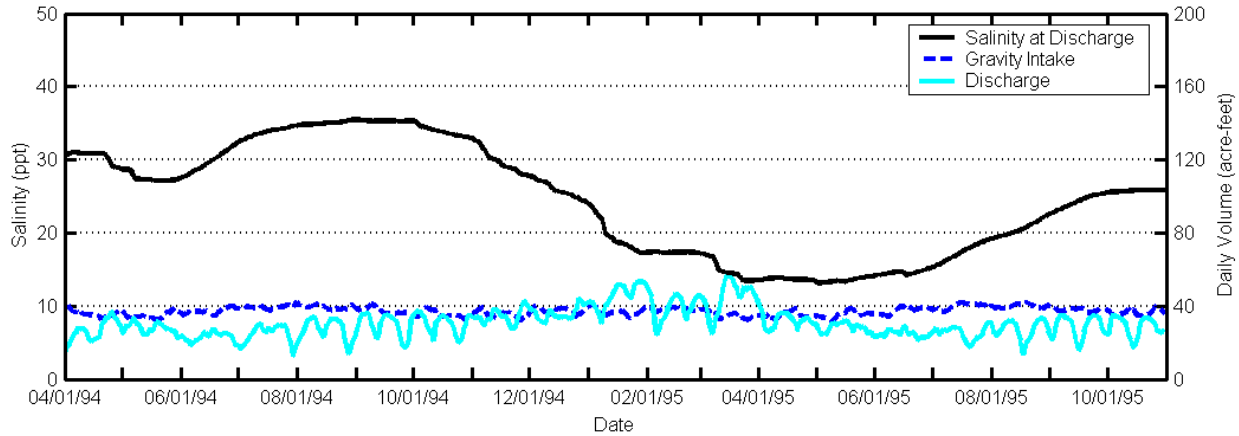
Table 4.2.1.3 shows the existing average summer and winter salinity levels based on recorded values for the past 6 years. The salinity in pond A2W has not been measured on a regular basis in the past. The salinity of pond A2W was estimated to be between the measured values for pond A1 and pond A2E, which are adjacent to pond A2W in the existing salt operation.

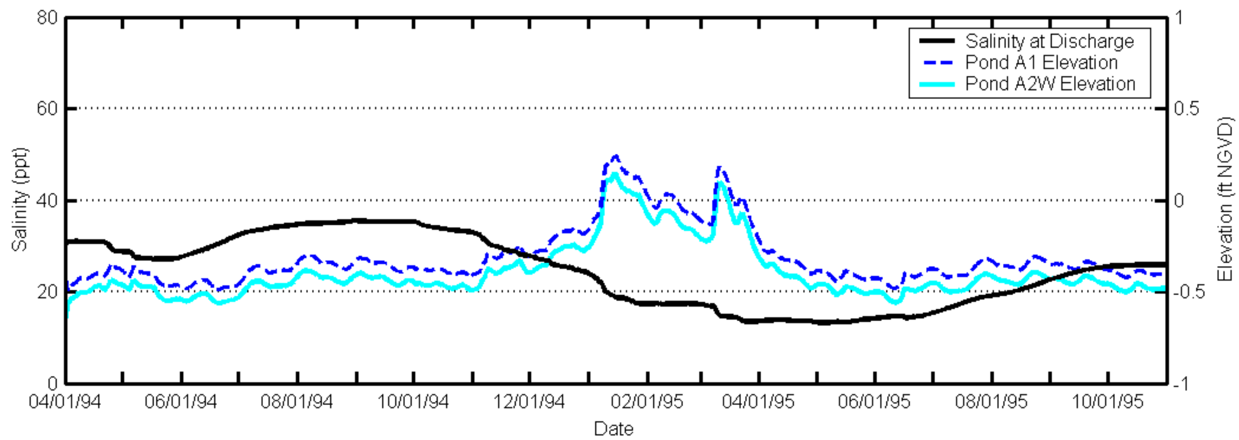
Table 4.2.1.3
System Alviso A2W Existing Pond Salinity

Pond	Area (acres)	Average Pond Salinity (ppt)		Salinity Range (ppt)
		Summer	**Winter**	
A1	277	26	22	11-42
A2W	429	28	25	15-43

The estimated pond salinities for the ISP operation would be within the range of the recorded pond salinities. Pond A1 is an existing intake pond and recorded salinities are close to bay salinity.

System A2W includes salinity group 1 ponds and could have a maximum initial discharge salinity of 65 ppt. If the salinity in the system were at the maximum at the start of bay water circulation, the discharge salinity would start at 65 ppt and decrease to be similar to the modeled conditions in Figure 4-2, Graph of Alviso A2W Operation Levels and Discharge Salinities, in a few months. Initial release scenarios, which include the maximum discharge salinity, have been modeled separately from the long-term salinity modeling for evaluation purposes.





Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

Figure 4-2
Graphs of Alviso A2W Operation Levels and Discharge Salinities

4.2.1.4 Management Operations

Ponds A1 and A2W will require limited active management. This would include on-going monitoring and inspections. The system may require adjustment of the control gates monthly or seasonally.

System A2W could be operated with reduced inflow and circulation during the winter season when evaporation is low. The proposed system includes an outlet weir to maintain minimum water levels with low flow rates. The system can be operated without an outlet weir, but may require more frequent adjustment of the control gates to control both water levels and salinities.

4.2.2 Alviso System A3W

Alviso System A3W consists of 5 ponds: B1 (intake), B2, A2E, A3W (outlet) and A3N, as shown in Figure 4-3. The objectives for the system include:

- Establish tidal circulation through ponds B1, B2, A2E and A3W
- Establish pond A3N as a seasonal or batch operation pond
- Maintain water surface elevations close to existing levels
- Maintain discharge salinity levels below 40 ppt.
- Locate new intake to prevent entrainment of salmonids should Stevens Creek support salmonids in the future
- Locate outfall to minimize disturbance to marsh along the A3W slough levee

The proposed plan would include the following structures:

- Existing 36” gate intake structure from the Bay at B1
- New 48” gate intake from the Bay at B1
- New 48” gate between B1 and A2E
- Existing 2x36” pipes in series between A2E and A3W.
- New 36” gate between B2 and A3W
- Existing gap between B1 and B2
- Existing 24” gate between B2 and A3N
- Existing 24” gate between A2N and A3W
- New 3x48” gate outlet at A3W to Guadalupe Slough. Two would be outlet only, and one would allow both inflow and outflow
- Existing staff gages at all ponds

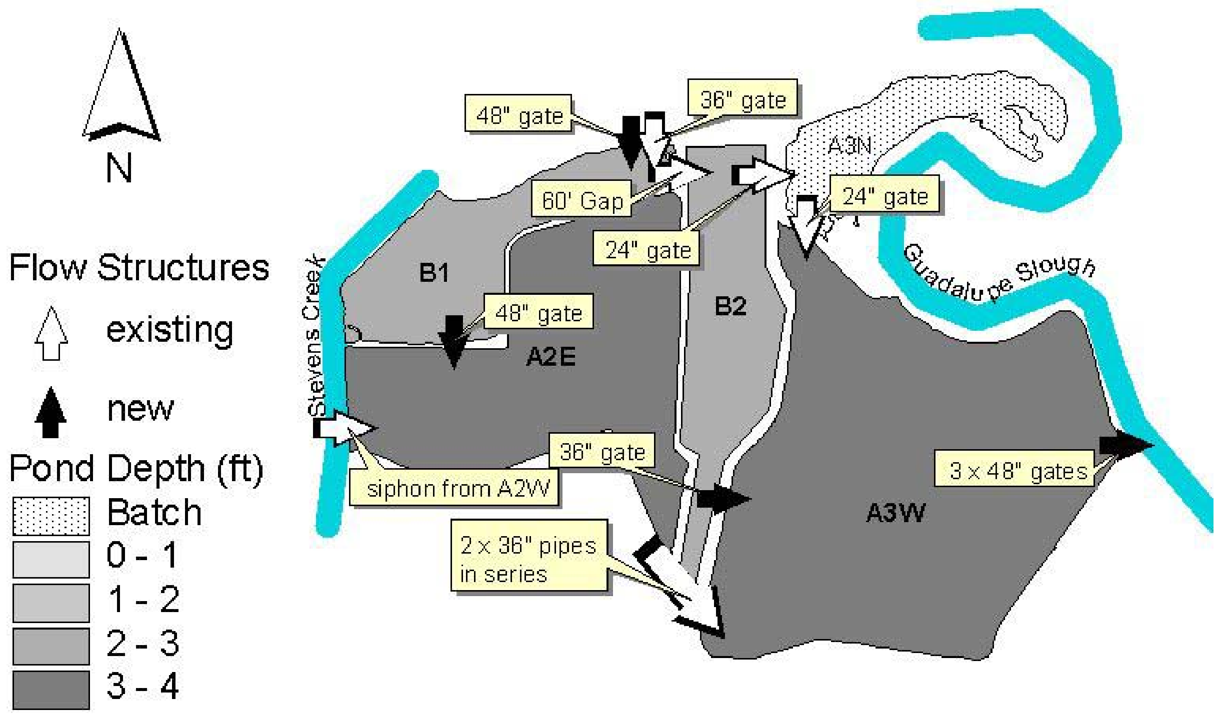


Figure 4-3
Map of Alviso A3W Inflow and Outflow Locations

4.2.2.1 Circulation Hydraulics

The intake location at the northeasterly end of B1 was selected to be near the existing intake and avoid inflow from the bay near the mouth of Stevens Creek. Stevens Creek has been identified as a potential salmonids fishery and migrating salmonids could be entrained in the intake flow if the intake were at Stevens Creek.

The outlet location at the easterly end of A3W was selected to allow outflow into Guadalupe Slough in close proximity to the existing dock structure near the Sunnyvale WWTP discharge. At that location, the new outfall would have the least impact on existing marsh along the slough levee.

The proposed control gates will allow intake at the outlet structure. It may be useful to intake at A3W to the dilute the pond volume if the pond salinity exceeds the discharge goals. Because of the flapgates and the relative elevations of the tide and pond water levels, all intake flow would occur at high tide, and all outflows would occur at low tide.

The long term discharge salinity levels at A3W would be at or above bay salinity, and would generally be higher than low tide salinity in Guadalupe Slough. Due to freshwater inflow from San Thomas Aquino Creek, Calabazas Creek, and the Sunnyvale WWTP, the salinity in Guadalupe Slough is typically lower than bay salinity, particularly at low tide water levels.

4.2.2.2 Interim Management Conditions

The system structure location map and graphs of pond operation flows, water levels and discharge salinities for the Alviso System A3W are shown in Figures 4-3 and 4-4.

Pond A3N was not included in the continuous operation model for the system. Pond A3N would operate as a seasonal or batch pond. As a seasonal pond, the pond would capture rainwater during the winter, and likely be dry during the summer. The pond salinity would not be controlled, but would fluctuate due to residual salt in the pond, rainwater inflows, and seasonal evaporation. As a batch pond, Pond A3N would not be subject to continuous flow. The volume and frequency of the intake and release would control the pond salinity in A3N similar to the existing operation levels. Water would be diverted from B2 to add volume to A3N, and discharged to A3W as needed to control water levels and salinity.

The predicted summer and winter daily average and peak flow rates for both the intake and outlet are shown in Table 4.2.2.2.1, below.

Table 4.2.2.2.1
Alviso System A3W Inflow and Outflow

Period	Gravity Intake Flow		Outlet Flow	
	Average	Peak	Average	Peak
Summer May - October	35 cfs 16,000 gpm	110 cfs 49,000 gpm	27 cfs 12,000 gpm	210 cfs 94,000 gpm
Winter November - April	32 cfs 14,000 gpm	110 cfs 50,000 gpm	34 cfs 15,000 gpm	250 cfs 110,000 gpm

The predicted water surface elevations during the initial stewardship period are shown in Table 4.2.2.2.2, below.

Table 4.2.2.2.2
Alviso System A3W Water Surface Elevations

Pond	Area (acres)	Bottom Elevation (ft NGVD)	Water Elevation (ft NGVD)		
			Existing	Initial Stewardship	
				Summer	Winter
B1	142	-0.8	0.7	0.4	0.9
A2E	310	-3.1	-1.2	-0.5	0.0
B2	170	-0.6	0.7	0.4	0.9
A3W	560	-3.2	-1.3	-1.4	-1.1
A3N	163	-1.4	-0.8	-	-
Total/ Average	1,345	-2.5	-0.4	-0.3	0.2

As modeled, the water level in the outlet Pond A3W will be within 0.1 ft of the existing average depth. The average water depth will be about 1.8 feet in summer and 2.1 feet in winter. The control gate settings were not adjusted to actively manage the pond water levels. Active management could maintain a more uniform water surface elevation in the ponds if necessary.

4.2.2.3 Salinity

The estimated discharge salinity from pond A3W into Guadalupe Slough is shown in Figure 4-4. The model results are shown for the entire simulation period from April 1994 to October 1995. The model simulation period includes a dry year and a wet year to evaluate discharge salinities for a range of summer operation conditions.

The initial pond salinities and water surface elevations were based on measured conditions in early April 2002. The pond system transitions from the initial starting conditions in the first 4 to 6 weeks of operation.

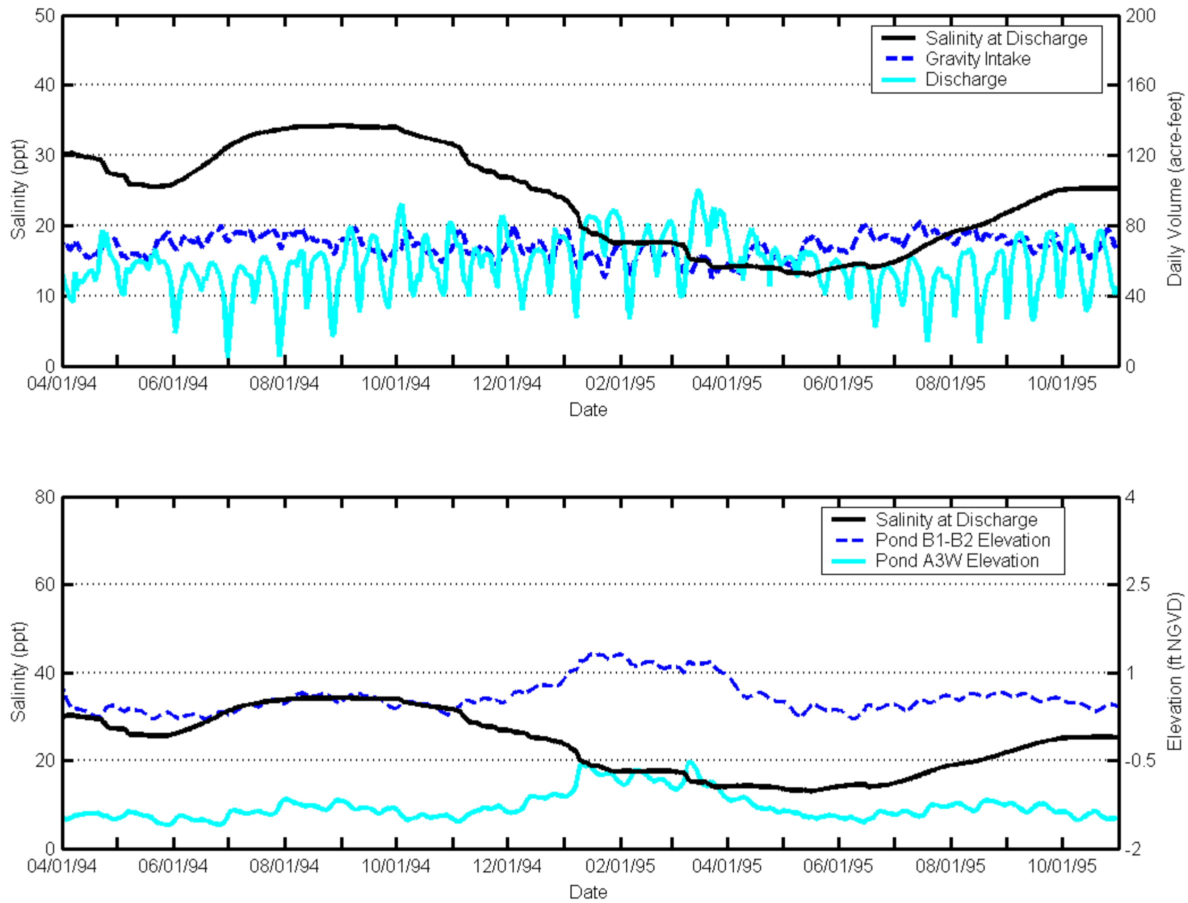
Pond A3N was not included in the pond hydraulic model and no initial stewardship condition salinity has been estimated for it. However, pond A3N may be operated as a batch or seasonal pond and therefore the salinity in it may be higher than in the other ponds in the A3W system.

Table 4.2.2.3 shows the existing average summer and winter salinity levels based on recorded values for the past 6 years.

Table 4.2.2.3
Alviso A3W System Existing Pond Salinity

Pond	Area (acres)	Average Pond Salinity (ppt)		Salinity Range (ppt)
		Summer	Winter	
B1	142	24	21	13-41
A2E	310	30	28	18-43
B2	170	26	22	13-43
A3W	560	34	30	23-44
A3N	163	27	25	16-41

System A3W includes salinity group 1 ponds and could have a maximum initial discharge salinity of 65 ppt. If the salinity in the system were at the maximum at the start of bay water circulation, the discharge salinity would start at 65 ppt and decrease to be similar to the modeled conditions in Figure 4-4 in a few months. Initial release scenarios which include the maximum discharge salinity have been modeled separately from the long term salinity modeling for evaluation purposes.



Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

Figure 4-4
Graphs of Alviso A3W Operation Levels and Discharge Salinities

4.2.2.4 Management Operations

Ponds B1, B2, and A3W will require limited active management. The intake, internal connections, and outlet structures generally have sufficient capacity and gravitational for salinity control in winter and spring.

Pond A3N would be operated as a seasonal or batch pond. For seasonal operations, the pond would be drained initially and no further operation would be required. The pond would fill with 1 to 2 feet of rainwater during the winter, which would evaporate during the summer. Because the bottom of pond A3N is 1½ feet below sea level, some groundwater seepage may occur to keep portions of the pond bottom wet during the summer.

Pond A3N has existing gates to operate as a batch pond. Water would be released from B2 to A3N to manage the volume in the pond and thus manage the amount of salt in the pond. This may affect the circulation in B1, B2, and A3W and may require additional analysis of flow rates and mixing in A3W. If the salinities in A3N become significantly higher than the salinity in A3W, there may be constraints on the discharge flow to A3W and the Guadalupe Slough. The flows through B1 and B2 to A3W would need to dilute the higher salinity inflow from A3N to a level that could be discharged from A3W. This may be limited during the summer high evaporation season due to the hydraulics of the system.

The discharge flow from gravity outlet from pond A3W to Guadalupe Slough may be affected by high flood tides during periods of high rainfall. There is a low levee on the south side of the pond which can be eroded by wave action if the water levels are high. It may be preferable to limit or stop inflow to the system during the winter to control the maximum water level. This is similar to the existing commercial salt operation. The outlet gates would need to be adjusted after large storms to drain excess volume from the system. Based on system model estimates, the outlet culverts would have capacity to allow circulation during the winter.

4.2.3 Alviso System A7

System A7 consists of 3 ponds: A5 (intake) and A7 (outlet) and seasonal pond A8 as shown in Figure 4-5. The objectives for the system include:

- Establish tidal circulation through the pond system through A5 and A7
- Establish pond A8 as a seasonal or batch operation pond
- Consider operating pond A8 at high salinity (120-150 ppt) during summer to favor brine shrimp. This would require additional analysis of flows and salinities in the System A14 or System A7
- Maintain project water elevations similar to existing elevations
- Maintain discharge salinities at levels below 40 ppt
- Locate intake to minimize entrainment of migrating steelhead using Alviso Slough
- Allow reversal of intake and outlet flow to better manage salinity and to drain ponds after storm events

The proposed system would include the following structures:

- New 2x48” gate intake at A5 from Guadalupe Slough
- New cut at the internal levee between A5 and A7
- Fill existing cut at the north end of the internal levee between A5 and A7
- Existing 24” control gate from A7 to A8
- Existing 4,000 gpm pump from A8 to A11. Modify outlet piping to allow discharge to A7
- New 2x48” gate outlet at A7 into Alviso Slough
- Existing staff gage in both ponds.

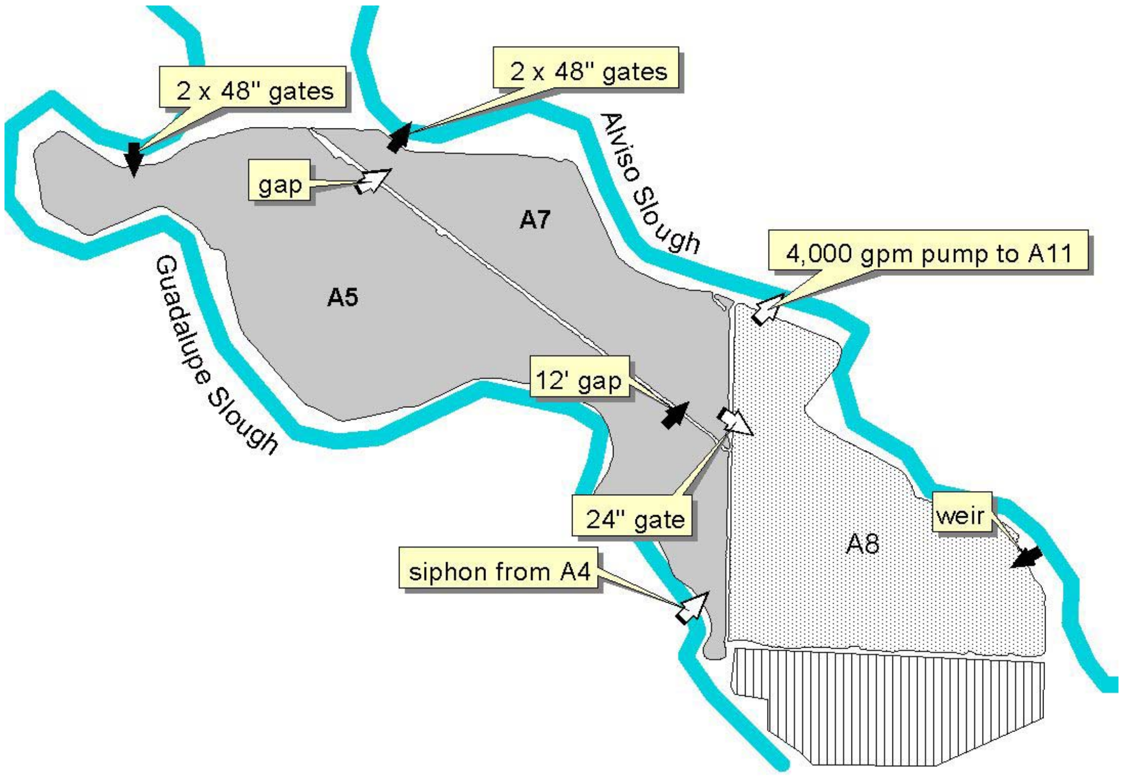


Figure 4-5
Map of Alviso A7 Inflow and Outflow Locations

4.2.3.1 Circulation Hydraulics

The intake location at the northwesterly end of A5 was selected to allow inflow from Guadalupe Slough as close to the bay as possible. The high tide salinities near the bay would be closer to normal bay salinity than farther upstream. Due to freshwater inflows from Calabazas and San Tomas Aquino Creeks, other drainage channels, and the Sunnyvale WWTP, the salinity upstream in Guadalupe Slough generally is lower than bay salinity. The bay salinity would be closer to existing conditions in the ponds.

The outlet location at the northerly end of A7 was selected to allow outflow into Alviso Slough as close to the bay as possible. The outlet salinity levels would be at or above bay salinity, but would generally be higher than low tide salinity in Alviso Slough. Due to freshwater inflow form Guadalupe River the salinity in Alviso Slough generally is lower than bay salinity, particularly at low tide levels.

The A7 intake location was avoided because of the presence of steelhead in the Guadalupe River which use Alviso Slough as a migration route. Intake of water from Alviso Slough during the migration seasons could entrain migrating fish.

4.2.3.2 Interim Management Conditions

The system structure location map and graphs of pond operation flows, water levels and discharge salinities for the Alviso System A7 are shown in Figures 4-5 and 4-6.

Pond A8 was not included in the continuous circulation operation model for the system. Pond A8 would operate as either a seasonal or batch pond. As a seasonal pond, the pond would contain rainwater during the winter, and generally be dry during the summer. The pond salinity would not be controlled, but would fluctuate due to residual salt in the pond, rainwater inflows, and seasonal evaporation. As a batch pond, Pond A8 would operate at a lower elevation than A5 or A7, similar to the existing operation levels. Water would be diverted from A7 to add volume to A8, and pumped to A11 or A7 as needed to control water levels and salinity. A8 would not require a continuous flow.

Additionally, the Santa Clara Valley Water District will use ponds A8, A5, and A7 to capture flood flows to minimize the extent and duration of flooding in Alviso resulting from the Lower Guadalupe River flood control project. An overflow weir will be constructed at A8 by the flood control project sponsor. Overflows would occur in major flood events greater than a 10-year flood in the lower Guadalupe River. When the ponds fill with floodwaters, the Water District will pump the ponds to drain floodwaters back to Alviso Slough or Guadalupe Slough. For more information see the Draft Lower Guadalupe River Flood Protection Project Mitigation and Monitoring Plan (Santa Clara Valley Water District, August 7, 2002). The proposed intake and outlet gates in ponds A5 and A7 would be available to supplement the discharge for flood overflows from System A7.

The estimated system flow rates for the long term ISP operation are shown in Table 4.2.3.2.1, below. The table includes average daily flow and peak flows for both the intake and outlet.

Table 4.2.3.2.1
Alviso System A7 Inflow and Outflow

Period	Gravity Intake Flow		Outlet Flow	
	Average	**Peak**	**Average**	**Peak**
Summer May - October	22 cfs 10,000 gpm	69 cfs 31,000 gpm	16 cfs 7,300 gpm	68 cfs 31,000 gpm
Winter November - April.	22 cfs 10,000 gpm	69 cfs 31,000 gpm	23 cfs 10,000 gpm	100 cfs 45,000 gpm

The predicted water surface elevations during the initial stewardship period are shown in Table 4.2.3.2.2, below. Note that Ponds A5 and A7 would operate at the same water elevations.

Table 4.2.3.2.2
Alviso System A7 Water Surface Elevations

Pond	Area (acres)	Bottom Elevation (ft NGVD)	Water Elevation (ft NGVD)		
			Existing	Initial Stewardship	
				Summer	Winter
A5	615	-0.6	0.1	0.4	0.6
A7	256	-0.5	0.1	0.4	0.6
A8	406	-3.4	-1.8	-	-
Total/ Average	1,277	-1.4	0.1	0.4	0.7

The control gate settings were not adjusted to actively manage the pond water levels in the pond model. Active management could maintain a more uniform water surface elevation in the ponds if necessary. For instance, the winter values shown are for a particularly wet (El Nino) winter and maximum pond elevations in A5 and A7 reached 1.0 ft NGVD, almost a foot above the 6-year average for these ponds. However, the pond water levels normally vary due to operational considerations and climatic conditions. A5 and A7 have exceeded elevation 0.6 ft during 2 of the past 6 winters.

4.2.3.3 Salinity

The estimated discharge salinity from pond A7 into Alviso Slough is shown in Figure 4-6. The model results are shown for the entire simulation period from April 1994 to October 1995. The model simulation period includes a dry year and a wet year to evaluate discharge salinities for a range of summer operation conditions.

The initial pond salinities and water surface elevations were based on measured conditions in early April 2002. The pond system transitions from the initial starting conditions in the first 4 to 6 weeks of operation.

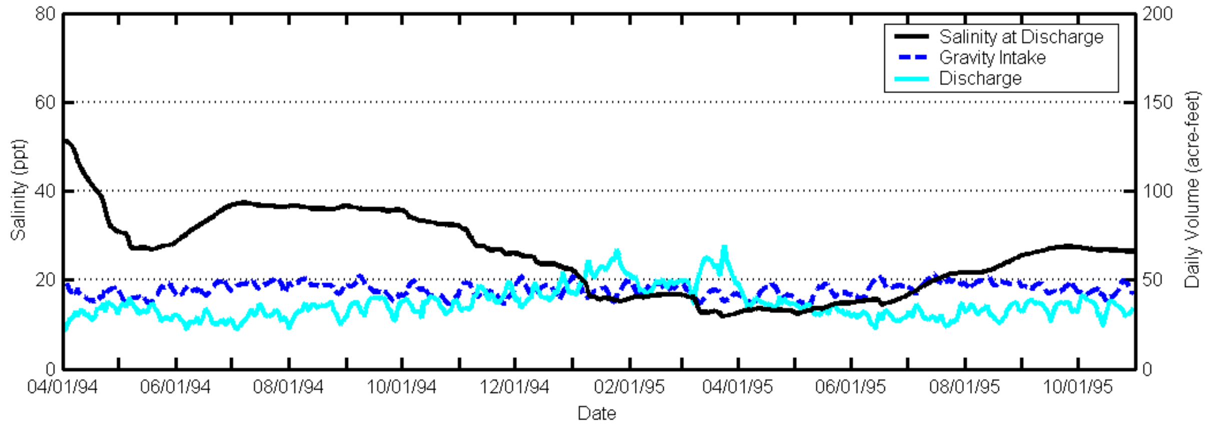
As noted previously, pond A8 was not included in the pond hydraulic model and no initial stewardship condition salinity has been estimated for A8. Since pond A8 is a batch or seasonal pond, the salinity can be adjusted using management alternatives. The salinity in A8 may be higher than in the other ponds in the system.

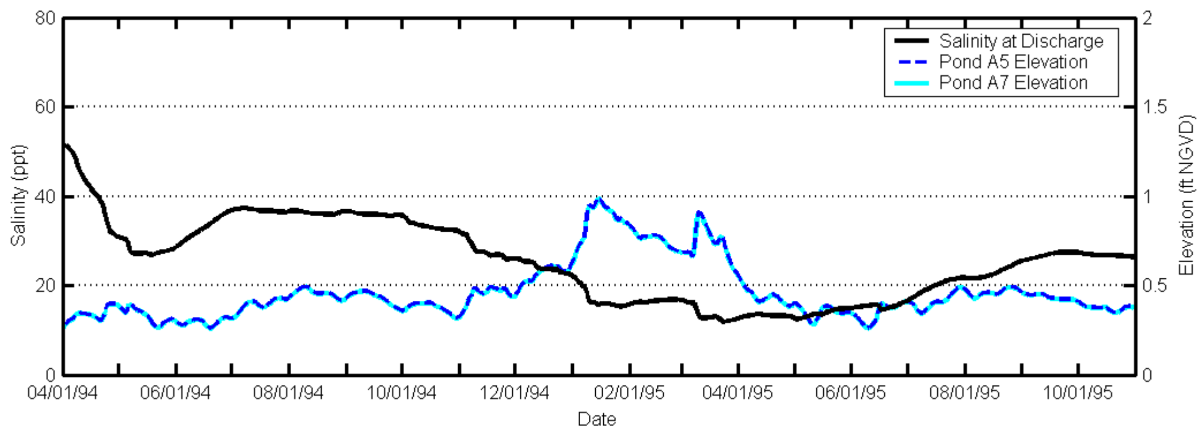
Table 4.2.3.3 shows the existing average summer and winter salinity levels based on recorded values for the past 6 years.

Table 4.2.3.3
Alviso System A7 Existing Pond Salinity

Pond	Area (acres)	Average Pond Salinity (ppt)		Salinity Range (ppt)
		Summer	Winter	
A5	615	45	41	28-60
A7	256	58	45	28-75
A8	406	74	60	31-110

System A7 includes salinity group 2 ponds and could have a maximum initial discharge salinity of 100 ppt. Ponds A5 and A7 may be as high as 110 ppt. If the salinity in the system were at the maximum at the start of bay water circulation, the discharge salinity would start at 110 ppt and decrease to be similar to the modeled conditions in a few months. Initial release scenarios that include the maximum discharge salinity have been modeled separately from the long-term salinity modeling for evaluation purposes.





Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

Figure 4-6
Graphs of Alviso A7 Operation Levels and Discharge Salinities

4.2.3.4 Management Operations

Ponds A5 and A7 will require limited active management. Pond A8 would be operated as a seasonal or batch pond. For seasonal operations, the pond would be drained initially and no further operation would be required. The pond would fill with 10 to 20 inches of rainwater during the winter, which would evaporate during the summer. Because the bottom of pond A8 is over 3 feet below sea level, some groundwater seepage may occur to keep portions of the pond bottom wet during the summer.

As a batch pond, A8 would not have continuous flow operation similar to A5 or A7. All outflows from A8 must be pumped to A11 or A7. The batch pond operation would minimize the amount of pumping required. Water would be diverted from A7 to maintain the volume in the pond. Water would be pumped from A8 to A11 or A7 to decrease the volume in the pond and reduce the amount of salt in A8. If the salinity in A8 is maintained at a level similar to the A11 or A7 levels, there would be no constraint on the timing and flow from A8 to A11 or A7.

If the salinity in A8 is significantly higher than the salinity in A11 or A7, there may be constraints on the flow to A11 or A7. The flow through the A14 system, which includes A11, or the A7 system, would need to dilute the higher salinity inflow from A8 to a level that could be discharged from A14 or A7. This may be limited during the summer high evaporation season due to the hydraulics of the system. The flow to A11 would also be limited during the winter when the flow through the A14 system would be reduced or closed to limit potential entrainment of salmonids.

Pond A5 includes an existing siphon under Guadalupe Slough from pond A4. Pond A4 has been acquired by the Santa Clara Valley Water District (SCVWD) for a proposed restoration project. Based on the proposed schedule for the long-term restoration of pond A4 there may be a requirement for interim management of the pond during the initial stewardship period for the DFG and FWS ponds. One or more alternatives being considered by the SCVWD for interim management may include operation of pond A4 as a batch pond with periodic outflows through the siphon to pond A5. If SCVWD and FWS agree that flows from A4 are appropriate the flows would be restricted to time periods and salinity levels which would not have a significant effect on flow rates or discharge salinities from pond A7. SCVWD would be responsible for preparation of a suitable operation plan for interim management of pond A4 in coordination with the operation of System A7.

4.2.4 Alviso System A14

System A14 consists of 7 ponds: A9 (intake), A10, A11 and A14 (outlet) and batch ponds A12, A13, and A15 as shown in Figure 4-7. The objectives for the system include:

- Establish tidal circulation through A9, A10, A11 and A14
- Establish a batch pond operation for ponds A12, A13, and A15
- Establish multiple intakes to batch ponds
- Operate batch ponds at high salinity (120-150 ppt) during summer to favor brine shrimp
- Maintain project condition water levels close to existing levels
- Maintain discharge salinity below 40 ppt

- Minimize entrainment of salmonids by limiting inflows during winter.

The proposed system includes:

- Existing 2x48" intake at A9 from Alviso Slough (intake flow only)

- Existing 48" control gates from:
  A9 to A10
  A10 to A11

- New control gate from A11 to A14.

- New 2x48" gate outlet at A14 into Coyote Creek

- Existing control gates for batch pond operations:
  48" gate from A11 to A12
  48" gate from A12 to A13
  36" gate from A14 to A1
  .

- Existing 22,000 gpm pump from A13 to A15.

- Existing siphon from A15 to A16

- New 48" gate intake at A15 from Coyote Creek

- Existing 36" control gate from A15 to A14

- Existing staff gages in all ponds

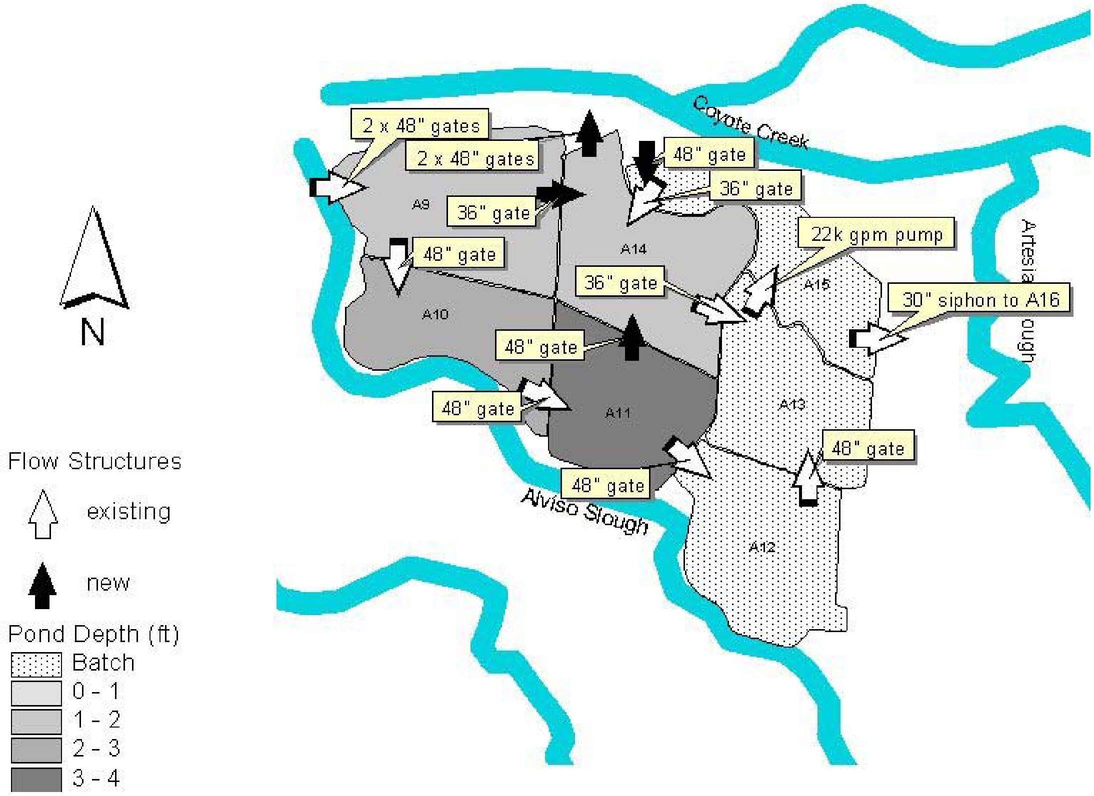


Figure 4-7
Map of Alviso 14 Inflow and Outflow Locations

4.2.4.1 Circulation Hydraulics

The existing intake at A9 allows intake only, and would not be modified. The new outlet structures would include operable gates and flapgates, to allow inflow at the outlet when necessary. For instance, it may be necessary to use A14 as a mixing chamber for higher salinity flows from A15, which may require inflows from Coyote Creek to A14. In addition, the control gates would allow partial culvert openings to control water levels. Because of the flapgates and the relative elevation of the tides and pond water levels, all intake flow would occur at high tide, and all outflows would occur at low tide.

The outlet location at the northerly end of A14 was selected to allow outflow into Coyote Creek at a location near an existing channel within the marsh area along the levee. The existing channel drains part of the marsh area to the existing dredge lock cut at the north end of A15. This would minimize the potential disturbance in the marsh.

Ponds A12, A13, and A15 are proposed for batch operations that will allow higher salinities in those ponds. The goal for these higher salinity ponds would be to reach summer salinity levels between 120 and 150 ppt to provide habitat for brine shrimp and wildlife which feeds on the brine shrimp. Lower salinity water would be diverted from ponds A11 and A14 in A12 and A13 and evaporation would increase the salinity over time. Higher salinity water would be pumped up to A15 as needed to maintain the pond volume. Additional low salinity water would be added to make up lost volume and lower salinity if needed. Excess volume in the batch system would be released to the A16 system for dilution and discharge to Artesian Slough and Coyote Creek.

Ponds A12, A13, and A15 are called a batch system because it is anticipated that the ponds will be operated in a series of batch operations to control the individual pond volumes and salinities. For example, a typical operation may be to add 3 inches of low salinity water from A11 to A12 to make up lost volume and reduce the pond salinity, or release 6 inches of water from A15 to A16 to lower the pond volume to make room for inflows from A12 and A13. Using individual transfers of volume from one pond to another simplifies the planning necessary for control of the pond salinities.

4.2.4.2 Interim Management Conditions

The system structure location map and graphs of pond operation flows, water levels and discharge salinities for the Alviso System A14 are shown in Figures 4-7 and 4-8.

Ponds A12, A13, and A15 were not included in the continuous operation model for the system because they would operate as batch ponds.

The estimated system flow rates using average daily flow and peak flows for both the inlet and outlet are shown in Table 4.2.4.2.1, below. The pond circulation model did not include adjustments in the flows for diversions to the batch ponds. No values are estimated for intake flows during the winter assuming the intake will be closed to avoid potential entrainment of migrating salmonids.

Table 4.2.4.2.1
Alviso System A14 Inflow and Outflow

Period	Gravity Intake Flow		Discharge Flow	
	Average	Peak	Average	Peak
Summer May - October	38 cfs 17,000 gpm	230 cfs 100,000 gpm	26 cfs 12,000 gpm	89 cfs 40,000 gpm
Winter November - April	-	-	9 cfs 3,900 gpm	44 cfs 20,000 gpm

The predicted water surface elevations during the initial stewardship period are shown in Table 4.2.4.2.2, below.

Table 4.2.4.2.2
Alviso System A14 Water Surface Elevations

Pond	Area (acres)	Bottom Elevation (ft NGVD)	Water Elevation (ft NGVD)		
			Existing	Initial Stewardship	
				Summer	Winter
A9	385	-0.2	3.9	2.0	1.5
A10	249	-0.8	2.5	1.8	1.5
A11	263	-1.8	1.7	1.3	1.4
A14	341	-0.0	1.4	0.9	1.3
A12	309	-2.0	1.4	-	-
A13	269	-1.1	1.2	-	-
A15	249	0.7	2.8	-	-
Total/ Average	2,440	-0.5	2.1	1.6	1.4

4.2.4.3 Salinity

The estimated discharge salinity from pond A14 into coyote Creek is shown in Figure 4-8. The model results are shown for the entire simulation period from April 1994 to October 1995. The model simulation period includes a dry year and a wet year to evaluate discharge salinities for a range of summer operation conditions.

The initial pond salinities and water surface elevations were based on measured conditions in early April 2002. The pond system transitions from the initial starting conditions in the first 4 to 6 weeks of operation.

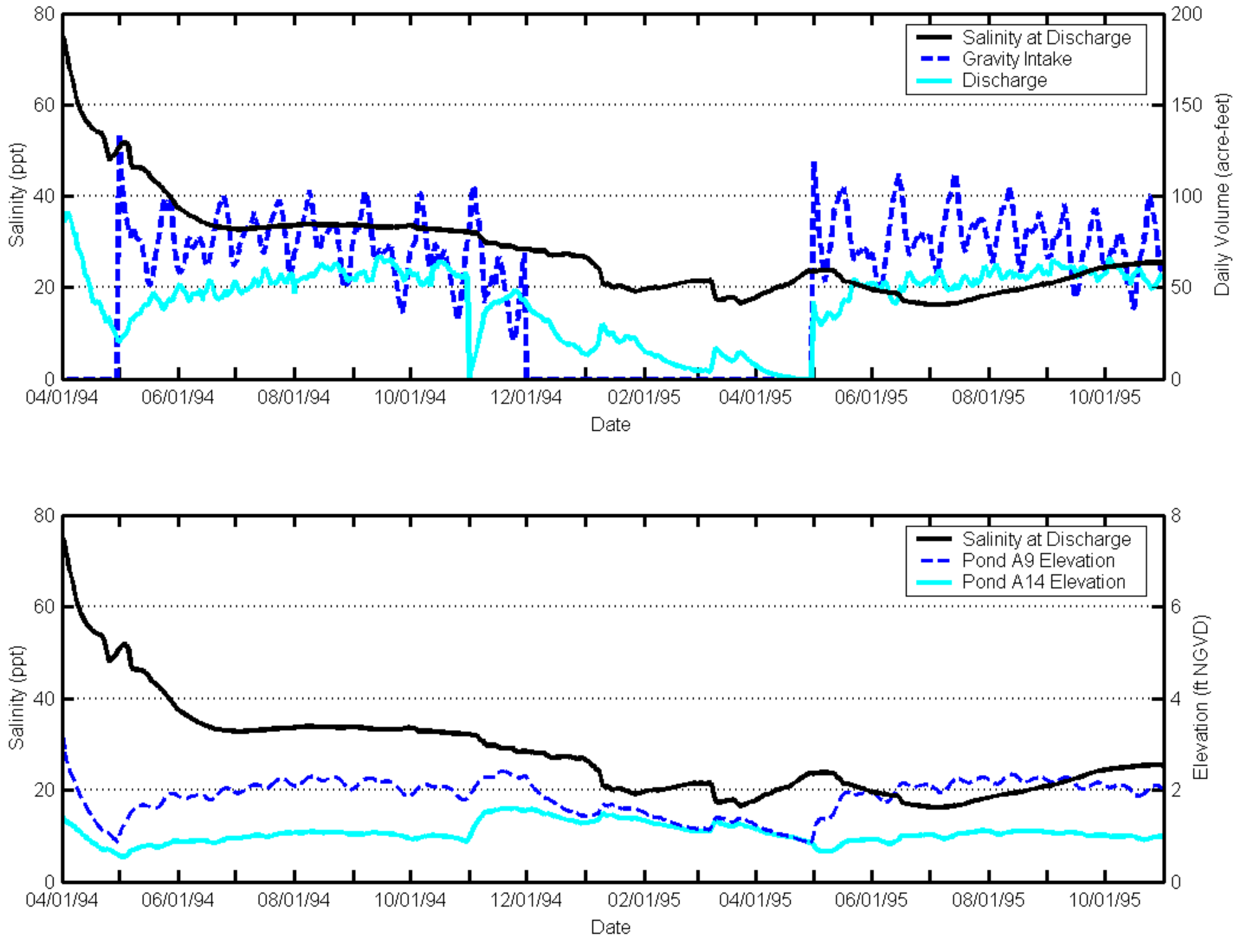
Table 4.2.4.3 shows the existing average summer and winter salinity levels in the ponds based on recorded values for the past 6 years.

Table 4.2.4.3
Alviso System A14 Existing Pond Salinity

Pond	Area (acres)	Average Pond Salinity (ppt)		Salinity Range (ppt)
		Summer	Winter	
A9	385	25	24	11-38
A10	249	28	26	17-45
A11	263	44	49	28-69
A14	341	85	75	48-135
A12	309	49	47	35-66
A13	269	58	52	38-77
A15	249	66	59	40-111

As noted previously, ponds A12, A13, and A15 were not included in the pond hydraulic model and no initial stewardship condition salinity has been estimated for the batch ponds. As batch ponds, the salinity can be adjusted using management alternatives. The proposed salinity in the batch ponds would be in the range of 120 to 150 ppt during the summer, but may be lower during the winter during wet years.

System A14 includes salinity group 2 and 3 ponds. The circulation ponds A9, A10, A11 and A14 are salinity group 2 ponds with a maximum initial salinity of 100 ppt. The batch ponds A12, A13, and A15 are salinity group 3 ponds with a maximum initial salinity of 135 ppt. A15 will be released through A16. Because the batch ponds would not be part of the circulation pond system and would not be included in the initial release, the initial release would have a maximum initial discharge salinity of 100 ppt if the salinity in the system is at the maximum. If the salinity in the system were at the maximum at the start of bay water circulation, the discharge salinity could start at 100 ppt and decrease to be similar to the modeled conditions in Figure 4-8 in a few months. Initial release scenarios which include the maximum discharge salinity have been modeled separately from the long term salinity modeling for evaluation purposes.



Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

Figure 4-8
Graphs of Alviso 14 Operation Levels and Discharge Salinities

4.2.4.4 Management Operations

Ponds A9, A10, A11, and A14 will require limited active management. During the winter season, the A9 intake would be closed to prevent entrainment of migrating salmonids. For planning purposes, this was assumed to extend from December through April. During the winter, rainfall would tend to increase the water levels in the ponds. The water levels in the ponds would be set by a weir at the outfall or adjustment of the control gates to avoid flooding of the existing internal levees or wave damage to the levees.

Ponds A12, A13 and A15 would be operated as batch ponds to maintain summer salinity levels in the range of 120 to 150 ppt for brine shrimp habitat. Water would be diverted from A11 or A14 into ponds A12 and A13 for makeup water as necessary to control salinity. Water would be pumped from A13 to A15 for makeup water in A15. Excess volume in A12 and A13 would be pumped up to A15. Excess water in A15 would be discharged to A16.

Because the proposed salinity in A15 would be significantly higher than the salinity in A16, there may be constraints on the flow to A16. The flow through the A16 system would need to dilute the higher salinity inflow from A15 to a level that could be discharged from A16. This may be limited during the summer high evaporation season due to the hydraulics of the system. It would also be limited during the winter when the flow through the A16 system would be reduced or closed to limit potential entrainment of salmonids from Coyote Creek at A17. If these constraints prevent intake from Coyote Creek, the flows will be reversed in the A16 system during the winter and intake from Artesian Slough instead of Coyote Creek.

The proposed intake to A15 from Coyote Creek would also allow flow from the creek into A15 during the summer. Inflows from the creek would have lower salinity than makeup water from A13. This would lower the salinity in A15, if necessary. In addition, control gates would be available from A9 to A14 and from A15 to A14. These gates could be used to increase the flow through A14 from A9 and allow A14 to be used as a mixing pond for releases from A15. Flow could also be released from A13 to A14 by adjusting the water level in A13.

For winter operation, the gates from A9, A10, and A11 were assumed to be open to allow rainfall to drain to A14. This would minimize the need for water level management during the winter. However, the water levels in A9 and A10 would be lower than existing conditions. The winter water level in A9 would be approximately 2.3 feet below the average winter water levels for the existing commercial salt operations. The winter water levels in each individual pond could be maintained at different water levels by closing the internal pond connection gates at the start of the winter season. Excess water from rainfall would need to be drained from the system after larger storms and would require additional active management to adjust the interior control gates.

The summer water level for pond A9 for the ISP condition is approximately 1.9 feet below the existing condition average summer water level. The lower water level was required to increase the intake flow through the existing intake gates and provide sufficient circulation flows to maintain salinities within the system. The gravity intake flows are dependent on the size of the intake structure and the pond water level in comparison to the slough water levels. More active management of water levels in the system may allow summer operation of ponds A9 and A10 at higher levels depending on the discharge salinities, flows to the batch ponds, and the intake salinities. The modeled discharge salinities at pond A14 were near 35 ppt during the summer with higher than normal intake salinities.

4.2.5 Alviso A16 System

System A16 consists of 2 ponds: A17 (intake) and A16 (outlet) as shown in Figure 4-9. The objectives for the system include:

- Establish tidal circulation through A17 and A16
- Maintain water surface levels close to existing levels
- Maintain discharge salinity levels below 40 ppt
- Minimize entrainment of salmonids by:
  Close A17 intake during winter, or
  Reversal of intake and outlet flow during winter
- Minimize potential for avian botulism by controlling salinity levels.

The proposed system would include:

- New 48” gate intake at A17 from Coyote Creek
- New 48” gate outlet structure at A16 into Artesian Slough
- Existing siphon between A15 (from System A14) to A16
- Existing gap between A17 and A16
- Existing staff gage in both ponds.

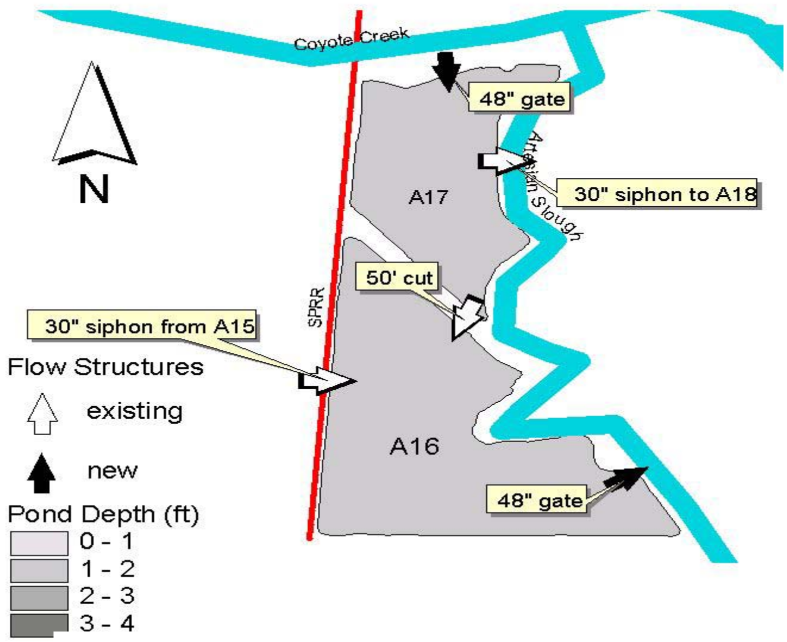


Figure 4-9
Map of Alviso 16 Inflow and Outflow Locations

4.2.5.1 Circulation Hydraulics

The inlet and outlet structures would include operable gates and flapgates to close off all flow, allow inflow only, or allow outflow only. Therefore, the inflow and outflow direction for the system could be reversed if necessary. For instance, a summer operation with an intake from Coyote Creek was preferred to avoid inflows from Artesian Slough at the City of San Jose wastewater treatment plant outfall. However, it may be necessary to intake at A16 from Artesian Slough during the winter to minimize potential entrainment of migrating salmonids in Coyote Creek. The control gates would allow partial culvert openings to control water levels. Because of the flapgates and the relative elevations of the tides and pond levels, all intake flow would occur at high tide, and all outflows would occur at low tide.

4.2.5.2 Interim Management Conditions

The system structure location map and graphs of pond operation flows, water levels and discharge salinities for the Alviso System A16 are shown in Figures 4-9 and 4-10.

The estimated system flow rates using average daily flow and peak flows for both the intake and outlet are shown in Table 4.2.5.2.1, below. No values are estimated for intake flows during the winter assuming the intake will be closed to avoid entrainment of migrating salmonids. For planning purposes, summer was considered May to October, and winter was November to April.

Table 4.2.5.2.1
Alviso System A16Inflow and Outflow

Period	**Gravity Intake Flow**		**Discharge Flow**	
	Average	**Peak**	**Average**	**Peak**
Summer May - October	15 cfs 6,800 gpm	106 cfs 48,000 gpm	12 cfs 5,400 cfs	32 cfs 14,000 gpm
Winter November - April	-	-	3 cfs 1,300 gpm	24 cfs 11,000 gpm

The predicted water surface elevations during the initial stewardship period are shown in Table 4.2.5.2.2, below. Note that Ponds A16 and A17 operate at the same water elevation.

Table 4.2.5.2.2
Alviso System A16 Water Surface Elevations

Pond	**Area (acres)**	**Bottom Elevation (ft NGVD)**	**Water Elevation (ft NGVD)**		
			Existing	**Initial Stewardship**	
				Summer	**Winter**
A17	131	1.1	2.7	2.3	2.2
A16	243	0.6	2.7	2.3	2.2
Total/ Average	374	0.8	2.7	2.3	2.2

Much of the variation in operating water levels in the ponds is due to the initial starting conditions and the transitions between winter and summer conditions. In particular, the ponds started at elevation 2.5 ft in April 1994 and the water level decreased over the first few weeks to below elevation 2.0 ft with no inflows in April. The water level then increased back to 2.5 ft. in May when the intake was opened to allow inflow from Coyote Creek and fluctuated between 1.7 and 2.6 ft for the rest of the simulation period.

4.2.5.3 Salinity

The estimated discharge salinity from pond A16 into Artesian Slough is shown in Figure 4-10. The model results are shown for the entire simulation period from April 1994 to October 1995. The model simulation period includes a dry year and a wet year to evaluate discharge salinities for a range of summer operation conditions.

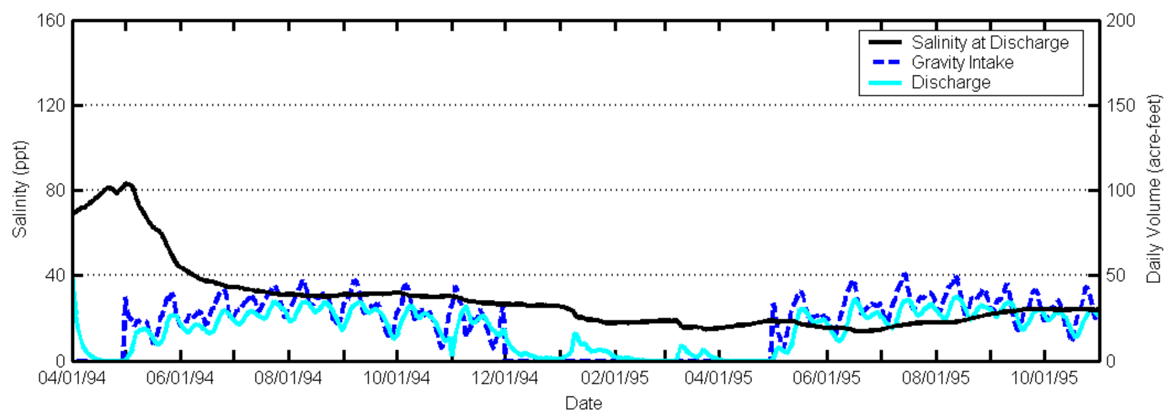
The initial pond salinities and water surface elevations were based on measured conditions in early April 2002. The pond system transitions from the initial starting conditions in the first 4 to 6 weeks of operation.

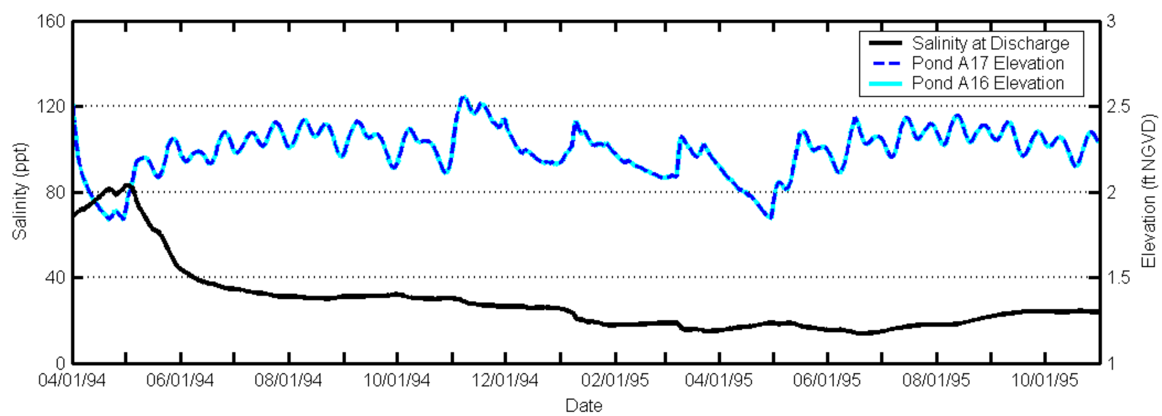
Table 4.2.5.3 shows the existing average summer and winter salinity levels based on recorded values for the past 6 years.

Table 4.2.5.3
Alviso System A16 Existing Pond Salinity

Pond	**Area (acres)**	**Average Pond Salinity (ppt)**		**Salinity Range (ppt)**
		Summer	**Winter**	
A17	131	77	67	45-137
A16	243	74	67	43-122

System A16 includes salinity group 3 ponds and could have a maximum initial discharge salinity of 135 ppt. If the salinity in the system were at the maximum at the start of bay water circulation, the discharge salinity would start at 135 ppt and decrease to be similar to the modeled conditions in Figure 4-10 in a few months. Initial release scenarios that include the maximum discharge salinity have been modeled separately from the long term salinity modeling for evaluation purposes.





Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

Figure 4-10
Graphs of Alviso 16 Operation Levels and Discharge Salinities

4.2.5.4 Management Operations

Ponds A16 and A17 will require limited active management. During the winter season, December through April, the A17 intake would be closed to prevent entrainment of migrating salmonids. The control gates would need to be adjusted weekly or monthly during the summer circulation period.

Pond A16 includes a siphon from pond A15 in the A14 system. As discussed in the previous section 4.2.1.6, A15 would contain higher salinity water between 120 and 150 ppt to provide brine shrimp habitat. Excess water from ponds A12, A13, and A15 would be released to A16 on a batch basis. Because the proposed salinity in A15 would be significantly higher than the salinity in A16, there may be constraints on the flow to A16. The flow through the A16 system would need to dilute the higher salinity inflow from A15 to a level that could be discharged from A16. This may be limited during the summer high evaporation season due to the hydraulics of the system. It would also be limited during the winter when the flow through the A16 system would be reduced or closed to limit potential entrainment of salmonids from Coyote Creek at A17. An operational alternative would be to reverse the flow in the A16 system during the winter and intake from Artesian Slough instead of Coyote Creek. Salinities in Artesian Slough are lower than in Coyote Creek due to the San Jose WWTP discharge, and may be more effective to dilute higher salinity inflows from A15. In addition, Artesian Slough does not have a salmonid fishery.

Based on the average salinity of the inflows from Coyote Creek and the average summer inflows to the A16 system, in an average year the release from the batch ponds through A15 to A16 would need to extend for approximately 4 months to prevent the salinity in A16 from exceeding 40 ppt.

4.2.6 Alviso Complex Island Ponds

The Alviso complex island ponds consist of ponds A19, A20, and A21 as shown in Figure 4-11. The proposed management for this system is a full tidal water regime. The objectives for the system include:

- Establish full circulation into ponds A19, A20, and A21
- Locate levee breaches to minimize disturbance to tidal marsh habitat

The system includes:

- New levee breaches:
  - 2 breaches, pond A19 to Coyote Creek
  - 1 breach, pond A20 to Coyote Creek
  - 2 breaches, pond A21 to Coyote Creek
- Seal and abandon existing siphons:
  - Siphon from pond A19 to A20
  - Siphon from pond A20 to A21
  - Siphon from pond A18 to A19
  - Siphon from pond A21 to plant 2
- Remove Coyote siphon pump
- Remove Mud Slough pump after transfer of brine to plant
- Remove existing control gate from pond A21 to Mud Slough pump

- Existing staff gages at all ponds.

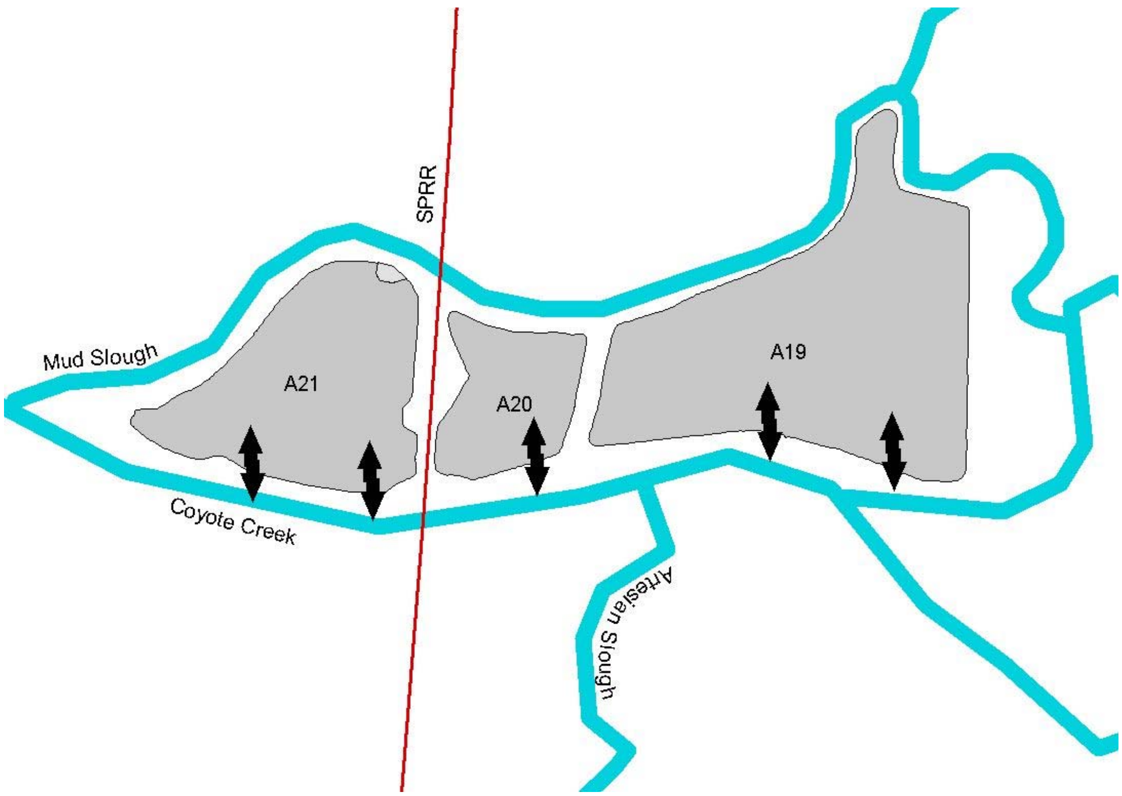


Figure 4-11
Map of Alviso Complex Island Breach Locations

4.2.6.1 Circulation Hydraulics

The island pond group contains three separate ponds. Each include one or more levee breaches to Coyote Creek to allow full tidal circulation within the pond. The ponds would each operate independently. The proposed breach locations were selected to avoid locations near the existing railroad bridge at Coyote Creek, and to minimize construction within the existing marsh areas along Coyote Creek.

The existing pond connection siphons would be sealed and abandoned. The existing Coyote siphon pump and Mud Slough pump would be removed.

4.2.6.2 Interim Management Conditions

The island pond breach locations are shown in Figure 4-11. The estimated water surface elevation for Coyote Creek and the island ponds for a typical two-day period are shown in Figure 4-12. The estimated tidal inflow conditions were based on hydrodynamic modeling of the Coyote Creek area including the proposed levee breaches.

For long term conditions, the individual breaches were assumed to be near the existing pond bottom elevations. The actual size would vary by location, but the largest breach was approximately 600 square feet below mean higher high water. The breach size was estimated to be consistent with existing studies which show that tidal breaches are generally stable with maximum velocities in the range of 2.8 to 3.8 fps (Goodwin, 1996). Due to limitations of the hydrodynamic model, the breaches were assumed to be one grid cell (25 meters) wide with depths approximately 5 ft below the pond bottom elevations.

The existing pond bottom elevations in the island ponds range from elevation 1.7 ft to 2.2 ft NGVD. The borrow ditches around the edges of the ponds are estimated to be 4 to 8 feet below the typical pond bottom elevations. Based on the estimated water levels shown in Figure 4-12, the pond bottoms would only be inundated at higher high tide levels. Only limited portions of the pond bottoms may be inundated at lower high water. Therefore, the pond bottoms would be inundated for 6 to 10 hours per day. The borrow ditch areas may be inundated for most of the day with some deeper areas inundated at all times.

The estimated mean tidal prism and mean higher high tide prism are shown in Table 4.2.6.2, below.

Table 4.2.6.2.1
Alviso Island Pond System Tidal Prism Volume

Pond	**Mean Tidal Prism**	
	All High Tides	**Higher High Tides**
A19	470 af	640 af
A20	150 af	190 af
A21	290 af	390 af

The predicted water surface elevations during the initial stewardship priod are shown in Table 4.2.6.2.2, below.

Table 4.2.6.2.2
Alviso Island Pond System Water Surface Elevations

Pond	Area (acres)	Bottom Elevation (ft NGVD)	Water Elevation (ft NGVD)		
			Existing	Initial Stewardship	
				Summer	Winter
A19	265	1.8	3.8	2.9	2.5
A20	63	1.8	3.7	2.8	2.5
A21	147	2.3	3.5	3.3	3.1
Total/ Average	475	2.0	3.7	3.0	2.7

4.2.6.3 Salinity

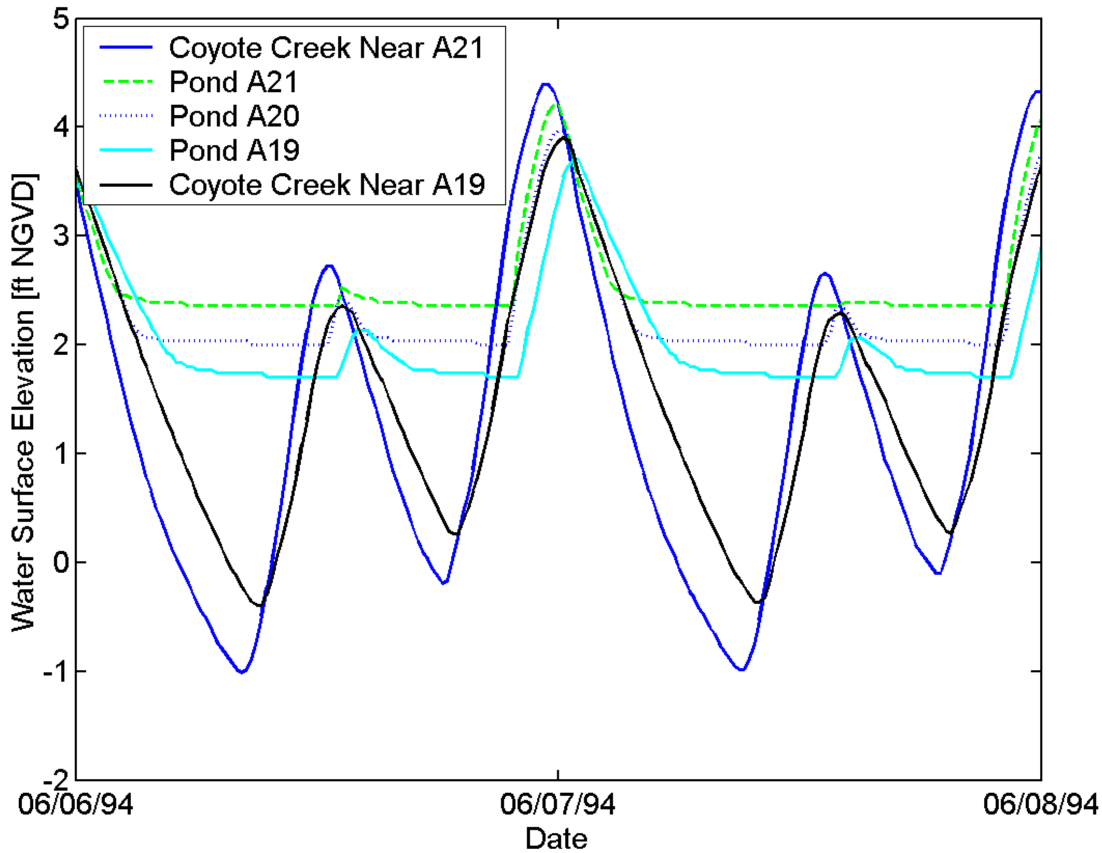
Table 4.2.6.3 shows the existing average summer and winter salinity levels in the island ponds based on values recorded for the past 6 years.

Table 4.2.6.3
Alviso Island Pond System Existing Pond Salinity

Pond	Area (acres)	Average Pond Salinity (ppt)		Salinity Range (ppt)
		Summer	Winter	
A19	265	152	132	79-290
A20	63	158	139	87-289
A21	147	173	151	87-304

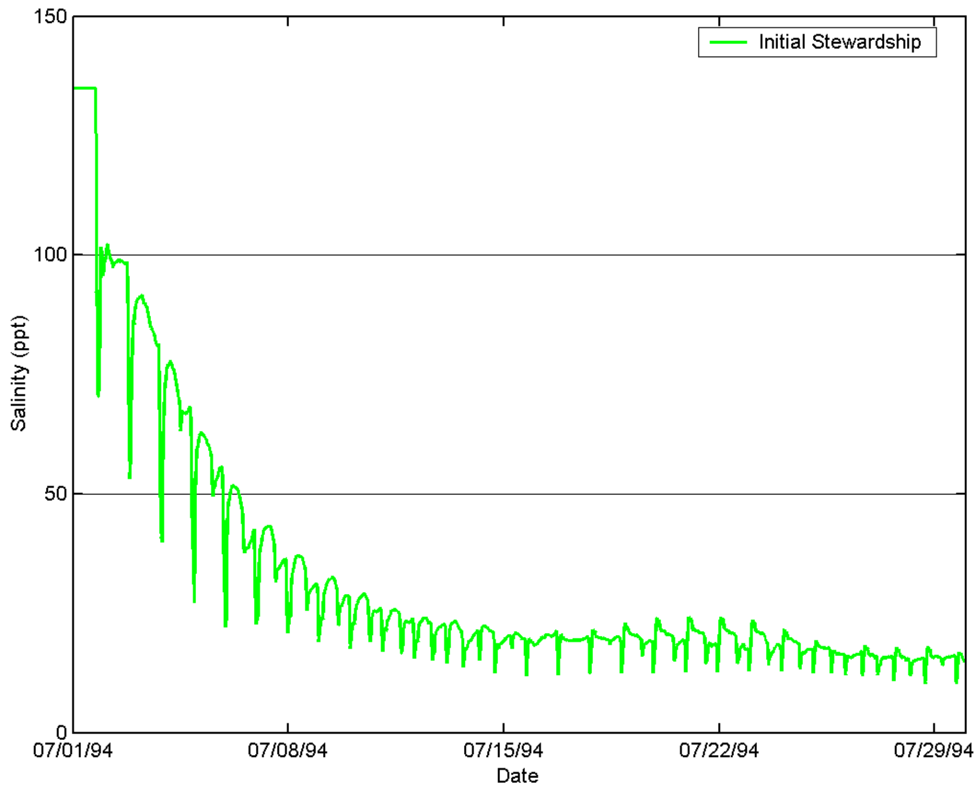
The initial breach conditions for the island ponds were modeled using the hydrodynamic model for two initial breach scenarios. The initial breach scenarios were based on an initial pond salinity at the maximum value of 135 ppt, with the starting water levels at 2.2 ft NGVD, the bottom elevation of pond A21. The pond volume above that elevation would be transferred to Cargill Plant 2 using the Mud Slough pump before the pump is removed. The initial breaches were modeled to be approximately 25 meters wide at the average pond bottom elevation. The constructed initial breaches may be narrower, which would reduce the initial flows to and from the ponds. The proposed scenario would phase the initial breach openings for the three ponds beginning with pond A19, followed 2 days later by pond A20 and 2 additional days later by pond A21. An alternative breach scenario included initial breach elevations at 1 ft NGVD.

The estimated pond salinities at the breach locations are shown in Figures 4-13 to 4-15. As shown in the salinity graphs, the initial salinities begin at approximately 135 ppt and rapidly decrease to near Coyote Creek values within one to two weeks. The pond salinities at the breach locations show daily fluctuations due to the inflows of lower salinity water from Coyote Creek on incoming tides and subsequent mixing with higher salinity water within the pond and borrow ditches.



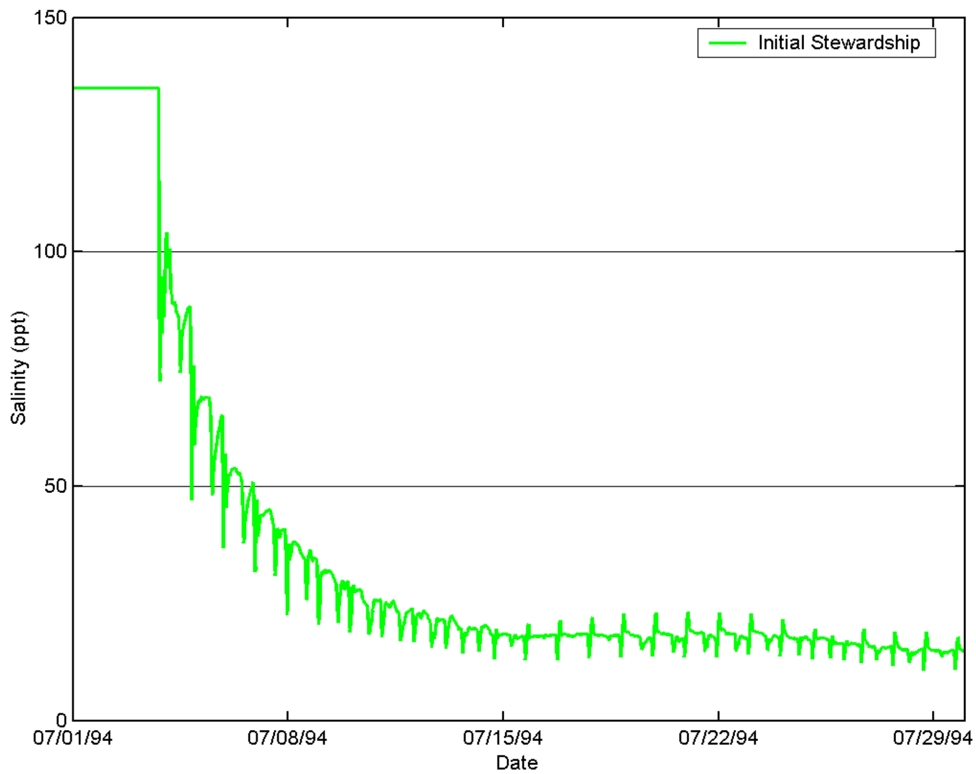
Note: Pond operation predicted based on 1994-1995 weather and tidal conditions

Figure 4-12
Graphs of Coyote Creek, Alviso Ponds A19, A20 & A21 Operation Levels



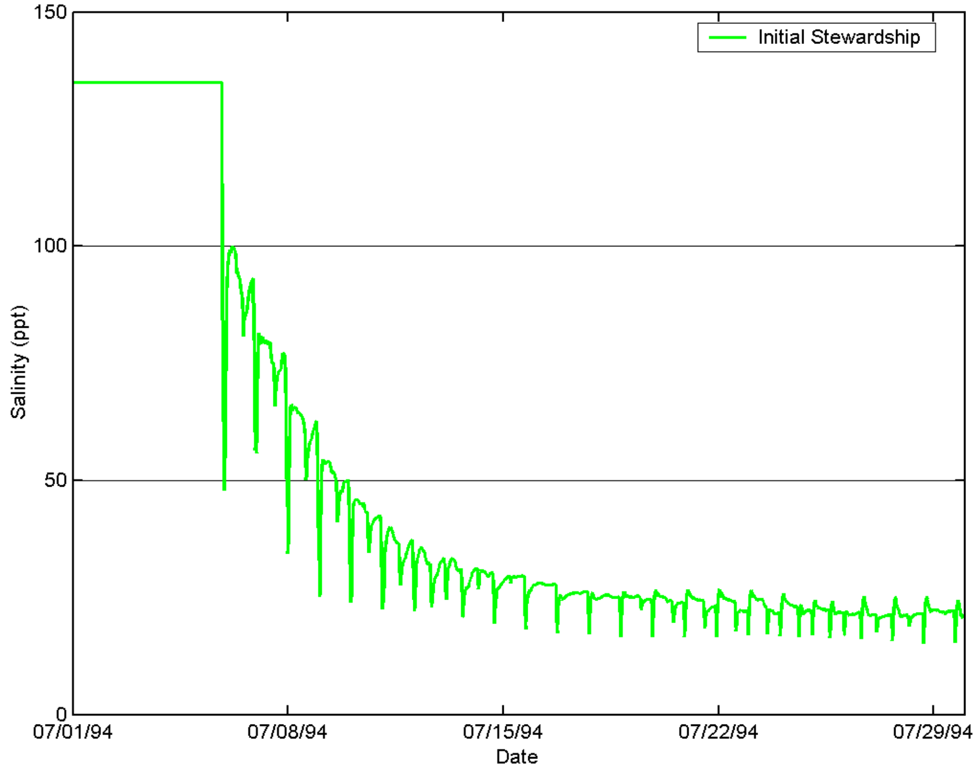
Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

Figure 4-13
Modeled Salinity at Alviso A19 Breach for Initial Release



Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

Figure 4-14
Modeled Salinity at Alviso A20 Breach for Initial Release



Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

Figure 4-15
Modeled Salinity at Alviso A21 Breach for Initial Release

4.2.6.4 Management Operations

The island ponds with the proposed breaches will require no active management or maintenance. It is anticipated that the existing levees will degrade over time due to erosion from rainfall, tidal flows, and flood flows. The pond bottom areas would become middle level salt marsh areas.

As noted previously, the proposed initial breach sizes may not be stable. The estimated maximum breach velocities for certain breach locations may be higher than 4 fps. The initial breach size and configuration would be expected to erode over time to a more stable configuration. The size and shape of the stable breaches would depend on the long-term circulation through the individual breach, the elevation of the Coyote Creek marsh at the location, and the durability of the soils within the levee. Depending on the site conditions, the individual breaches may become both deeper and wider.

An alternative management plan for the island pond group, which may be considered, would include operating the island ponds as seasonal ponds for the Initial Stewardship period. The existing brines in the ponds would be transferred to the Cargill Plant 2 to the maximum extent possible. The residual brines in the borrow ditches and low areas would evaporate in place. As seasonal ponds, the island ponds would partially fill with winter rainfall. The rainwater would evaporate during the spring and summer, and the ponds would be dry until the following winter. The seasonal pond alternative would not require construction of any intake or outlet structures. There would be no discharges to the bay or sloughs.

4.2.7 Alviso System A23

The Alviso system A23 consists of ponds A22 and A23 as shown in Figure 4-16. The objectives for the system include:

- Establish intakes for tidal inflows to ponds A22 and A23
- Establish potential outlets for future outflows from ponds A22 and A23
- Locate intake/outlet structures to minimize disturbance to tidal marsh habitat

The system includes:

- New 48" gravity intake/outlet structures:
  Pond A22 to Mud Slough
  Pond A23 to Mud Slough
- Existing pond connections:
  Wood box from A22 to A23
  24" gate from A22 to Crabby Joe pump vault
  24" gate from A23 to Crabby Joe pump vault
- Existing Crabby Joe pump to Cargill plant 2
- Existing staff gages at both ponds

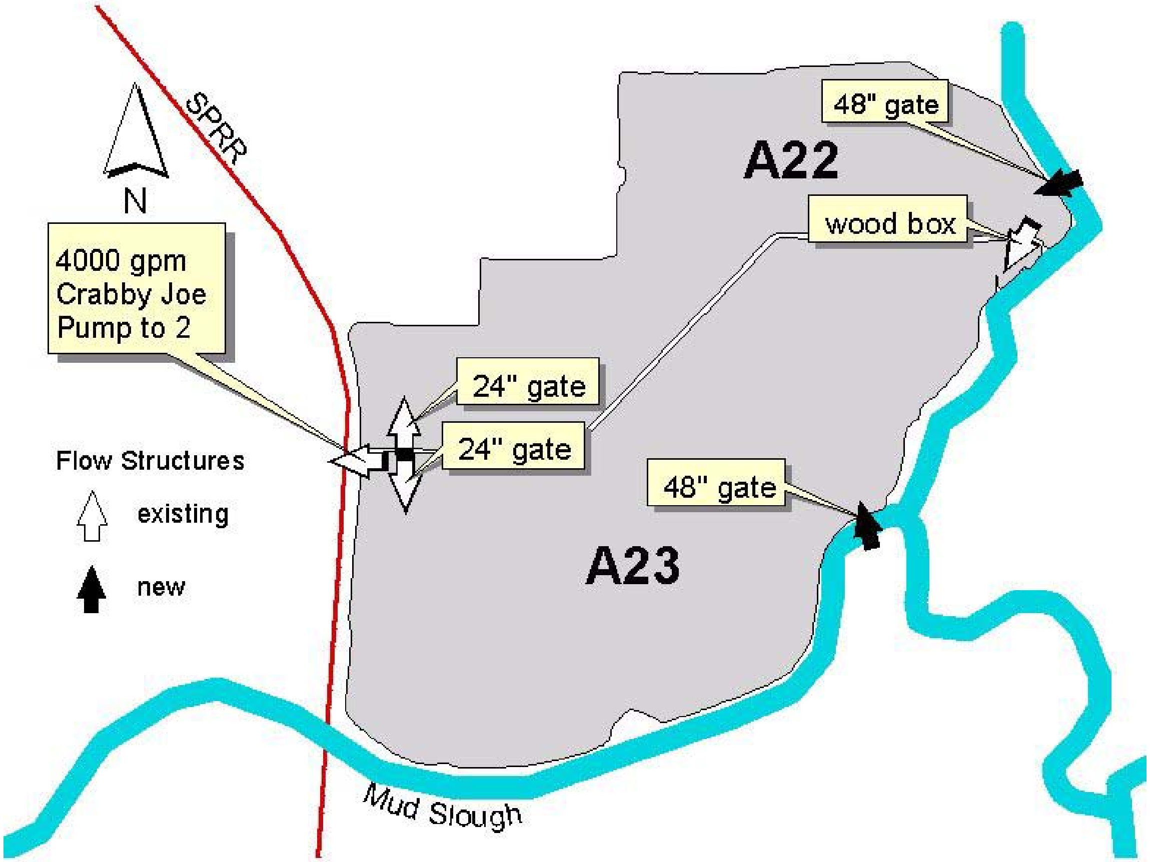


Figure 4-16
Map of Alviso A23 Inflow and Outflow Locations

4.2.7.1 Circulation Hydraulics

The A23 pond group would contain ponds A22 and A23. Based on current plans, there would be no discharge to Mud Slough.

During the initial stewardship period, the ponds may intake bay water from Mud Slough to dilute the pond contents, dissolve crystallized salt within the ponds, and move water to plant 2. The intakes from Mud Slough would only operate as a batch operation. All discharges from the pond group would be pumped to plant 2 using the Crabby Joe pump.

The intake/outlet structures would include the control gates necessary to allow discharge to Mud Slough only to provide flexibility for future restoration operations. Any future discharges from this system would be requested in a future discharge permit application.

4.2.7.2 Interim Management Conditions

The proposed inflow operations for ponds A22 and A23 have not been planned in detail. Inflows could occur to dissolve salt deposits in these ponds. The resulting brines would be brought into the existing Cargill salt operation. No discharge to Mud Slough would be included. No estimates for pond operation levels or salinities have been established. However, the proposed operation for A22 and A23 may be similar to existing water levels. Water levels have ranged from dry to 3 feet deep in A23 and from dry to 1.5 feet deep in A22. Summer operations would accommodate nesting by snowy plovers.

Table 4.2.7.2 shows the existing average summer and winter salinity levels based on values recorded for the past 6 years.

Table 4.2.7.2
Alviso System A23 Existing Pond Salinity

Pond	**Area (acres)**	**Average Pond Salinity (ppt)**		**Salinity Range (ppt)**
		Summer	**Winter**	
A22	270	236	185	66-296
A23	445	275	240	178-302

4.2.7.3 Management Operations

During the next 8 years, the A23 system will require minimal active management to open and close intake structure(s) as needed.

4.2.8 Baumberg System 2

The Baumberg System 2 consists of 4 ponds: ponds 1 (intake), 2 (outlet), 4 and 7 as shown in Figure 4-17. The objectives for the system include:

- Establish tidal circulation through the pond system through Baumberg 1, 4, 7 and 2
- Operate water surface levels lower than existing conditions
- Maintain discharge salinity levels below 40 ppt
- Manage for different water surface elevations summer vs. winter
  Summer water elevations lower than winter elevations to increase gravity inflow
- Summer average depth of at least 1-ft. ponds 1 and 2
- Summer partial dry-down in ponds 7 and 4
- Winter average depth of 1 ft. in all ponds
- Supplement inflow using the intake pump at pond 1 to control the summer salinity
- Allow reversal of flow at intake and outlet to drain ponds after storm events or serve as a contingency should gates fail

The proposed system includes:

- New 4x48" gate intake at pond 1 from Old Alameda Creek

- Existing 30,000 gpm intake pump station at pond 1 from Old Alameda Creek.

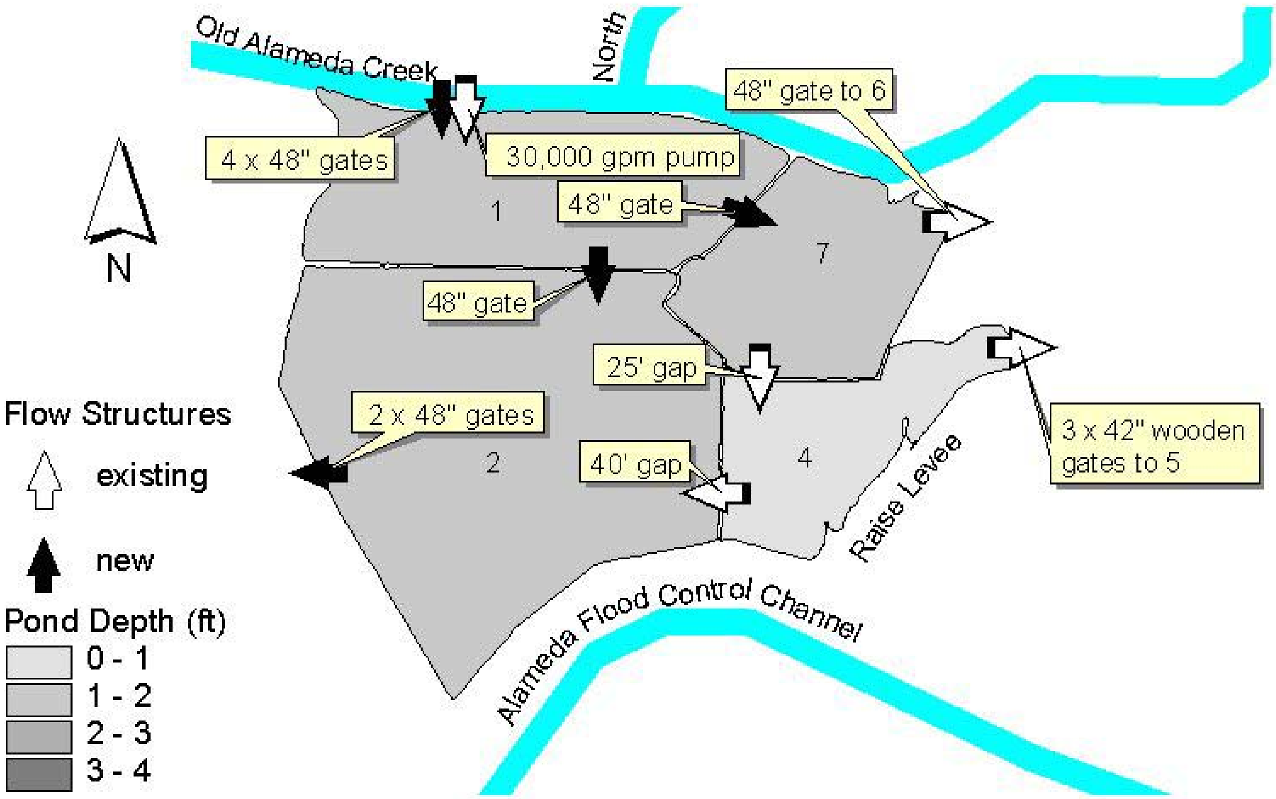
- New connection gates
  48" gate from pond 1 to 7.
  48" gate from pond 1 to 2.
  New 2x48" gate outlet structure with control weir at pond 2 into the Bay

- Existing levee gaps between
  Ponds 7 and 4
  Ponds 4 and 2

- Removal of existing gate(s) between
  Ponds 7 and 6
  Ponds 4 and 5
  Ponds 1 and 2

- Raise existing levees on east side of ponds 7 and 4

- Existing staff gages at all ponds.



Note: Pond depths based on winter conditions.

Figure 4-17
Map of Baumberg 2 Inflow and Outflow Locations

4.2.8.1 Circulation Hydraulics

The circulation pattern for the system would be to intake at pond 1, then flow through ponds 7 and 4 to the outlet at pond 2. All four intake culverts would include operable gates and flapgates to allow inflow. Two culverts would include gates to allow outflow, if necessary. Controls to allow outflow at the intake structure are included to maintain management flexibility and allow discharge from pond 1 in the event of flooding or a gate failure within the system. Because of the flapgates and the relative elevation of the tides and pond levels, all gravity intake flow would occur at high tide, and all outflows would occur at low tide.

The existing intake pump station at pond 1 will remain to supplement gravity inflows into the system during the summer high evaporation period. Because the pond bottom elevations and water elevations are relatively high, the gravity flow intakes are effective only during short periods at high tides. During periods of weak tides, little gravity inflow would occur and the pump would be needed to supplement the inflow. The intake pump station also operates only at high tide.

The outlet structure at pond 2 to the Bay would include operable gates and flapgates to close off all flow or allow outflow only. The control gates at the intake and outlet culverts would allow partial culvert openings to control water levels.

The initial stewardship conditions would include different operation plans for the winter and summer. The operating water levels in the ponds would be lower during the summer to increase the gravity inflow into the system during the higher evaporation season. The water level in pond 2 would be approximately 3.1 ft NGVD during the summer, and 3.4 ft NGVD during the winter. Because of the high bottom elevations in ponds 7 and 4, they would be only partially wet during the summer.

4.2.8.2 Interim Management Conditions

The system structure location map and graphs of pond operation flows, water levels and discharge salinities for the Baumberg System 2 are shown in Figures 4-17 and 4-18.

The estimated system flow rates using average daily flow and peak flows for both the intake and outlet are shown in Table 4.2.8.2.1, below.

Table 4.2.8.2.1
Baumberg System 2 Inflow and Outflow

Period	**Gravity Intake Flow**		**Pumped Intake Flow**	**Discharge Flow**	
	Average	**Peak**		**Average**	**Peak**
Summer May – October	25 cfs 11,000 gpm	467 cfs 210,000 gpm	15 cfs 7,000 gpm	36 cfs 16,000 gpm	57 cfs 26,000 gpm
Winter November – April	4 cfs 1,900 gpm	363 cfs 160,000 gpm	4 cfs 2,000 gpm	10 cfs 4,400 gpm	14 cfs 6,100 gpm

The predicted water surface elevations during the initial stewardship period are shown in Table 4.2.8.2.2, below.

Table 4.2.8.2.2
Baumberg System 2 Water Surface Elevations

Pond	**Area (acres)**	**Bottom Elevation (ft NGVD)**	**Water Elevation (ft NGVD)**		
			Existing	**Initial Stewardship**	
				Summer	**Winter**
1	337	2.2	4.8	3.4	4.5
7	209	2.5	4.8	3.1	4.4
4	175	2.9	4.4	3.1	4.4
2	673	2.1	4.8	3.1	4.4
Total/ Average	1,394	2.3	4.7	3.2	4.4

4.8.2.3 Salinity

The estimated discharge salinity from pond 2 to San Francisco Bay is shown in Figure 4-15. The model results are shown for the entire simulation period from April 1994 to October 1995. The model simulation period includes a dry year and a wet year to evaluate discharge salinities for a range of summer operation conditions.

The initial pond salinities and water surface elevations were based on measured conditions in early April 2002. The pond system transitions from the initial starting conditions in the first 4 to 6 weeks of operation.

The pond hydraulic model assumes that pumping would start if the discharge salinity exceeds 37 ppt, and stop if the discharge salinity is below 36 ppt. Because the discharge salinity responds slowly to the increased inflow, the pumps generally would operate for several day or weeks at a time. The pumping criteria were developed to limit the maximum initial discharge salinity to less than 40 ppt. The pumping criteria could be modified to conform to other discharge goals. A higher allowable discharge goal would reduce the need for pumping.

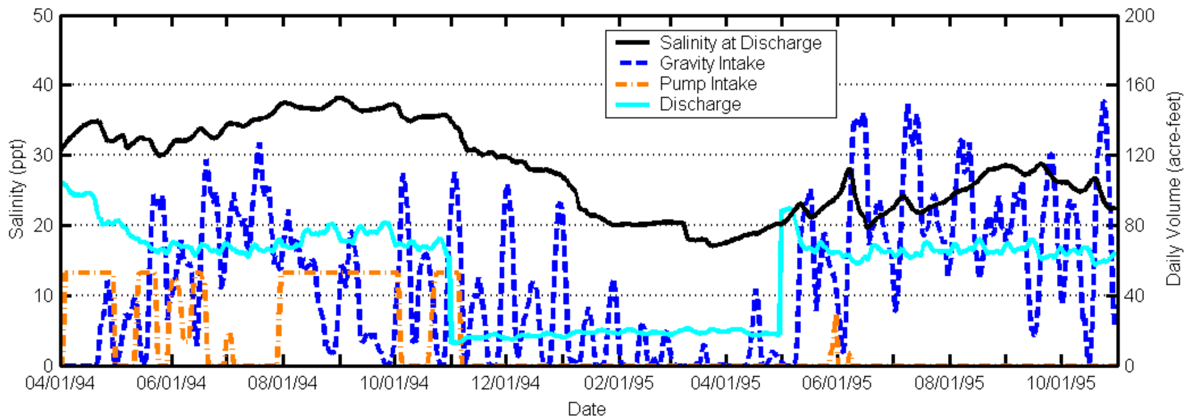
As shown in Figure 4-15, the system required significant pumping during the summer of 1994, which was a relatively dry year with relatively high salinity in the South San Francisco Bay. The following year, 1995 was much wetter. Therefore, the ponds started the summer with relatively low salinity and the intake water from the bay has a lower salinity. The model results show that only limited pumping would be required for the summer 1995 conditions.

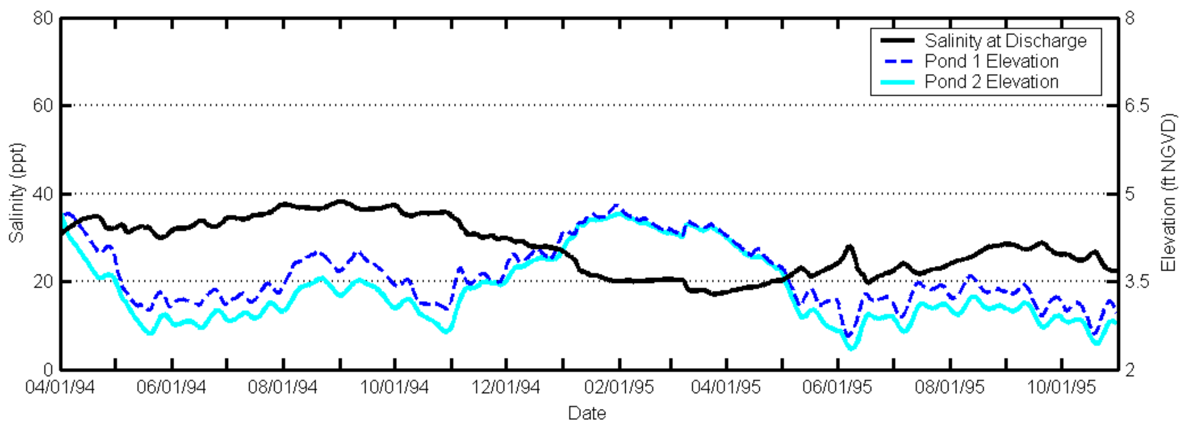
The initial stewardship plan would generally maintain the existing salinity levels in the ponds compared to the existing salt making operations. Table 4.2.8.3 shows the existing average summer and winter salinity levels in the ponds for the past 6 years.

Table 4.2.8.3
Baumberg System 2 Existing Pond Salinity

Pond	Area (acres)	Average Pond Salinity (ppt)		Salinity Range (ppt)
		Summer	Winter	
1	337	31	27	18-46
7	209	42	33	23-59
4	175	41	30	16-60
2	673	35	29	20-49

System 2 includes salinity group 1 ponds and could have a maximum initial discharge salinity of 65 ppt. If the salinity in the system were at the maximum at the start of bay water circulation, the discharge salinity would start at 65 ppt and decrease to be similar to the modeled conditions in Figure 4-15 in a few months. Initial release scenarios which include the maximum discharge salinity have been modeled separately from the long term salinity modeling for evaluation purposes.





Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

Figure 4-18
Graphs of Baumberg 2 Operation Levels and Discharge Salinities

4.2.8.4 Management Operations

Baumberg System 2 will require active management during the summer, as well as during the transitions to and from the summer operation. The intake culverts do not have sufficient capacity to allow adequate flow for salinity control during the summer. The inflow may need to be supplemented using the intake pump to control the summer salinity. It is anticipated that the supplemental pump would be controlled manually based on the measured salinity in pond 2 on approximately a weekly basis. The intake pump includes an automatic level switch to turn the pump on at high tide and off at low tide.

For the winter operation, the gate from pond 1 to pond 7 would be open and the gate from pond 1 to pond 2 would be closed. Water from the bay would circulate from pond 1 to 7, to 4, and to pond 2. Because of rainfall and low evaporation during the winter, no supplemental pumping would be required in normal years. The water level in the system would be controlled by the outlet gate settings.

In the spring the system would be changed to the summer operation condition. This was assumed to occur in early May, but could vary depending on habitat conditions in the ponds. For example, the transition could be delayed or advanced based on use of the pond by migratory birds, or salinity levels in the ponds.

For the summer operation, the planned water levels would be lower by approximately 1 foot. The water levels in the system would be controlled by the outlet gate settings. The lower operating levels throughout the system would provide a significant increase in the gravity inflow from the intake culverts in pond 1. In addition, the gate from pond 1 to pond 2 would be at least partially opened to reduce the headloss for flow from pond 1 to pond 2. The gate from pond 1 to pond 7 would be partially open to provide limited circulation through ponds 7 and 4.

Based on modeling of the system for historic tide and evaporation conditions in 1994, the gravity intake system would not be sufficient to maintain the maximum salinity goals during periods of weak tides. Gravity inflows would only occur at high tide levels in the bay. During periods of weak tides, with lower high tides, the inflow would be reduced. Weak tide periods may extend for a week to 10 days. With low inflows from the bay and high evaporation, the salinity levels in the ponds would increase, and may exceed the design goal of 40 ppt. Therefore, supplemental pumping would be provided from the existing intake pump from Old Alameda Creek to pond 1. A proposed operation scheme was developed in which pumping would start if the discharge salinity exceeds 37 ppt, and stop if the discharge salinity is below 36 ppt. Because the discharge salinity responds slowly to the increased inflow, the pumps generally would operate for several days or weeks at a time. The pumping criteria could be modified to conform to other discharge goals. A higher allowable discharge goal would reduce the need for pumping. Based on the pond modeling for 1994 and 1995, the supplemental pumping would be necessary during summer periods with higher Bay intake salinity, but may not be required during wet years with lower ambient salinity in the Bay.

4.2.9 Baumberg System 2C

The Baumberg System 2C consists of eight ponds: ponds 6 (intake), 5, 6C, 4C, 3C, 2C (outlet), 1C (intake) and 5C as shown in Figure 4-19. The objectives for the system include:

- Establish two tidally-initiated pumped circulation systems
  - A main system through Baumberg ponds 6, 5, 6C, 4C, 3C, and 2C
  - A smaller system through ponds 1C and 5C
- Operate water levels similar to existing levels
- Maintain discharge salinity levels below 40 ppt. System will require active management

- Manage for different water surface elevations summer vs. winter

- Inflows using the intake pumps to control the summer salinity

The proposed system includes:

- New 30,000 gpm intake pump station at pond 6 from Old Alameda Creek

- Existing connection gates and/or pipes
  Remove 4x45" gate from pond 6 to 5
  Remove 36" pipe from pond 5 to 6C
  Remove 45" gate from pond 5 to 6C
  2x30" pipes from pond 6C to 4C
  Remove 2x30" gate from pond 4C to 3C
  25' gap from pond 3C to 2C
  25' gap from pond 5C to 4C
  25' gap from pond 1C to 5C
  Remove 24" pipe from pond 1C to 5C
  Remove 30" pipe from 2C to Cal Hill transfer pump

- Remove Cal Hill transfer pump

- Seal and abandon siphon from Cal Hill transfer pump to plant 1

- Seal and abandon siphon from Continental pump to pond 6

- New connections
  15' gap from 6 to 5
  2x48" gates from 5 to 6C

- Existing 7,660 gpm intake pump station at pond 1C from Alameda FCC

- New 2x48" gate outlet at pond 2C into the Alameda Flood Control Channel (FCC)

- Existing staff gages in all ponds

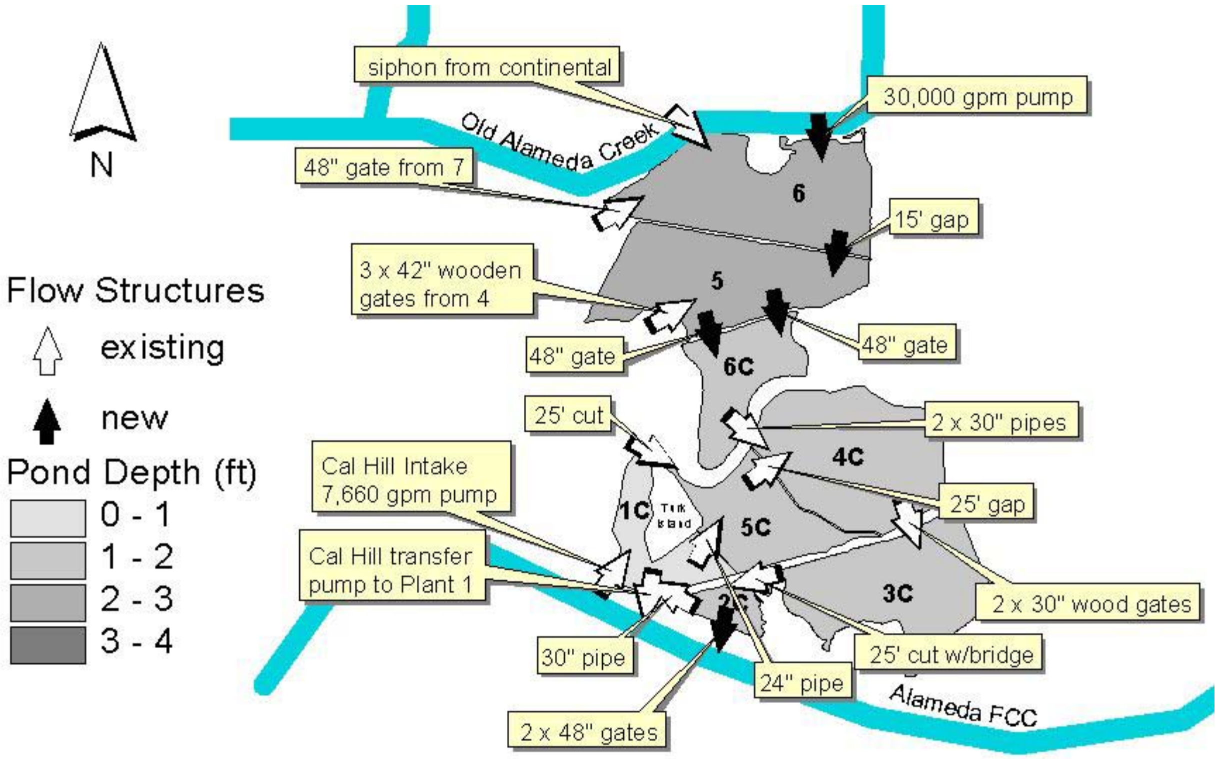


Figure 4-19
Map of Baumberg 2C Inflow and Outflow Locations

4.2.9.1 Circulation Hydraulics

The proposed intake pump would provide continuous circulation through ponds 6, 5, 6C, 4C, 3C, and 2C during the summer months. Water would be pumped primarily during high tide into pond 6 and then be conveyed by gravity into ponds 5, 6C, 4C, 3C and 2C. A new gravity outlet at pond 2C consisting of two 48" gates would discharge flows into the Alameda FCC.

The existing intake pump at pond 1C would operate to provide inflows to a smaller sub-system consisting of pond 1C and 5C. This pond sub-system would operate on a continuous basis or could be operated seasonally as a batch system to allow higher salinity in ponds 1C and 5C. Pond 5C would discharge to pond 4C.

Flows through both these two sub-systems would be primarily unidirectional to pond 2C. The outlet structure from pond 2C would discharge to Alameda FCC through two 48" flapgates at low tide. The new outlet in pond 2C would be constructed as close to San Francisco Bay as possible. The outlet structure would also include a weir to control the minimum water level in pond 2C. The weir would include weir boards to adjust the weir elevation.

The control gates at the intake and outlet culverts would allow partial culvert openings to control water levels. Because of the flapgates, all gravity outflows would occur during low tide in the channel. Because of the shallow depths in Old Alameda Creek, all pumped inflows would occur at high tide.

The initial stewardship conditions would include different operation plans for the winter and summer. The operating water levels in the lower ponds (4C, 3C, and 2C) would be slightly lower during the summer to increase the gravity flow through the system from the upper ponds (6, 5, and 6C) during the higher evaporation season. The water level would vary approximately 1 foot in elevation NGVD during the summer between the upper and lower ponds.

4.2.9.2 Interim Management Conditions

The system structure location map and graphs of pond operation flows, water levels and discharge salinities for the Baumberg System 2C are shown in Figures 4-19 and 4-20.

The estimated system flow rates are shown in Table 4.2.9.2.1, below. The table includes average and peak discharge flows for both summer and winter. The pumped intake flows are limited to the summer season in order to balance evaporation from the pond system. The summer intake flows are just under the average discharge flows, accounting for summer evaporation rates. However, peak summer discharges may nearly triple the average discharge flows when the weir elevation is lowered. Average and peak winter discharge flows are much lower, approximately 70-80 percent less than summer flows. Although significant rainfall enters the pond system during winter, no pumped intake flows occur in winter and the weir elevation is raised almost a foot.

Table 4.2.9.2.1
Baumberg System 2C Inflow and Outflow

Period	**Gravity Intake Flow**		**Pumped Intake Flow**	**Discharge Flow**	
	Average	**Peak**		**Average**	**Peak**
Summer May – October	-	-	27 cfs 12,000 gpm	22 cfs 10,000 gpm	70 cfs 31,000 gpm
Winter November – April	-	-	3 cfs 1,500 gpm	6 cfs 2,600 gpm	21 cfs 9,400

The predicted water surface elevations during the initial stewardship period are shown in Table 4.2.9.2.2.

Table 4.2.9.2.2
Baumberg System 2C Water Surface Elevations

Pond	**Area (acres)**	**Bottom Elev (ft NGVD)**	**Water Elev (ft NGVD)**		
			Existing	**Initial Stewardship**	
				Summer	**Winter**
6	176	2.4	4.6	5.1	4.9
5	159	2.4	4.5	4.1	4.9
6C	78	2.8	4.4	5.0	4.9
4C	175	3.2	4.2	4.5	4.8
3C	153	2.9	4.3	4.1	4.7
5C	111	3.4	3.4	4.5	4.8
1C	66	3.6	3.5	4.5	4.8
2C	24	2.7	4.0	4.0	4.4
Total/Average	942	2.9	4.1	4.6	4.6

4.2.9.3 Salinity

The estimated discharge salinity from pond 2C to Alameda Flood Control Channel is shown in Figure 4-20. The model results are shown for the entire simulation period from April 1994 to October 1995. The model simulation period includes a dry year and a wet year to evaluate discharge salinities for a range of summer operation conditions.

The initial pond salinities and water surface elevations were based on measured conditions in early April 2002. The pond system transitions from the initial starting conditions in the first 4 to 6 weeks of operation.

The pond hydraulic model assumes that pumping would start if the discharge salinity exceeds 37 ppt, and stop if the discharge salinity is below 36 ppt. Because the discharge salinity responds slowly to the increased inflow, the pumps generally would operate for several days or weeks at a time. The pumping criteria were developed to limit the maximum initial discharge salinity to less than 40 ppt. The pumping criteria could be modified to conform to other discharge goals. A higher allowable discharge goal would reduce the need for pumping.

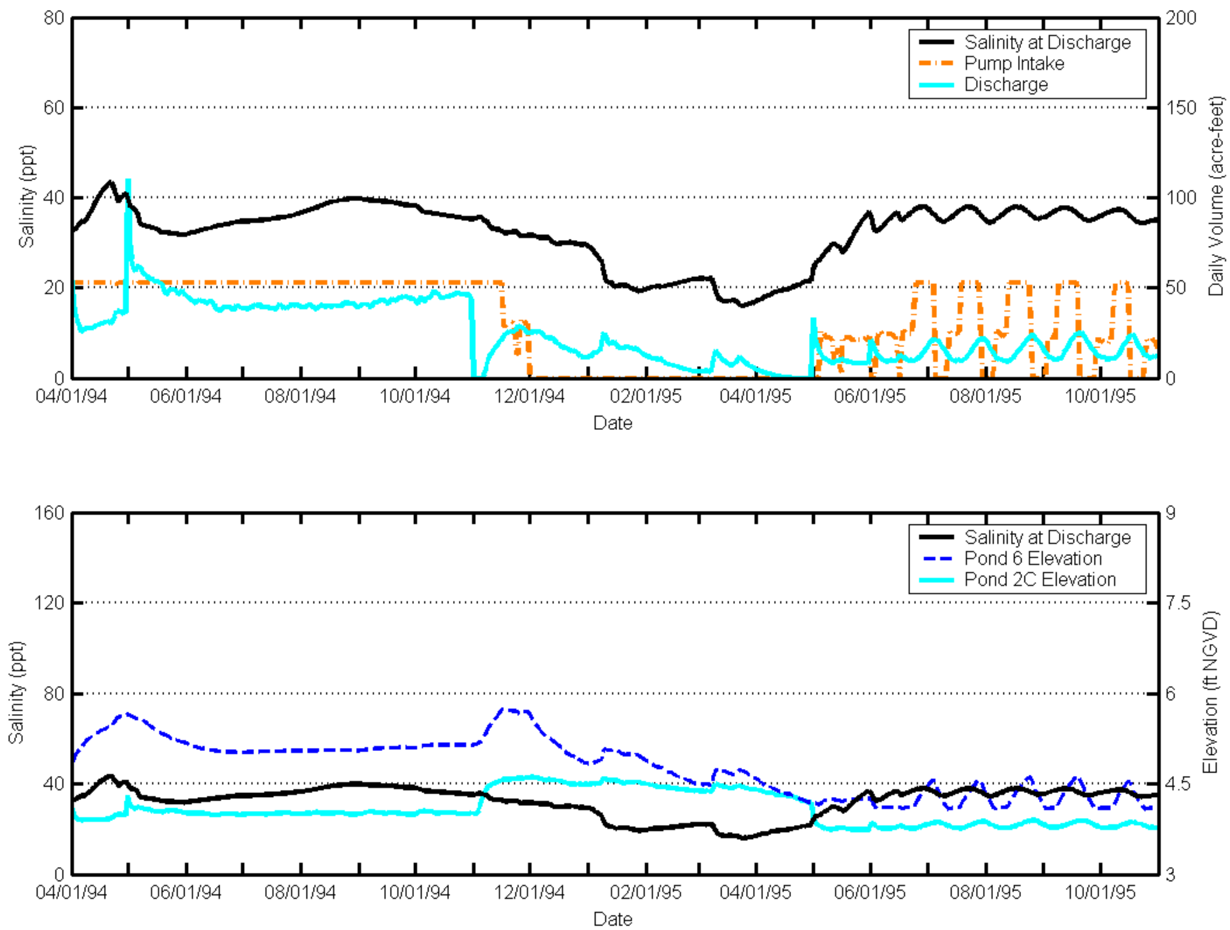
As shown in Figure 4-17, the system required significant continuous pumping during the summer of 1994, which was a relatively dry year with relatively high salinity in the South San Francisco Bay. 1995 was a much wetter year. Therefore, the ponds start the summer with somewhat lower salinity and the intake water from the bay has a lower salinity. Figure 4-18 shows that intermittent pumping was required for the summer 1995 conditions.

Table 4.2.9.3 shows the existing average summer and winter salinity levels based on recorded values for the past 6 years.

Table 4.2.9.3
Baumberg System 2C Existing Pond Salinity

Pond	**Area (acres)**	**Average Pond Salinity (ppt)**		**Salinity Range (ppt)**
		Summer	**Winter**	
6	176	67	64	25-148
5	159	64	62	23-149
6C	78	67	56	23-132
4C	175	72	49	23-143
3C	153	76	48	23-145
5C	111	61	49	20-136
1C	66	46	46	21-147
2C	24	77	48	20-178

System 2C includes salinity group 2 ponds and could have a maximum initial discharge salinity of 100 ppt. If the salinity in the system were at the maximum at the start of bay water circulation, the discharge salinity would start at 100 ppt and decrease to be similar to the modeled conditions in Figure 4-17 in a few months. Initial release scenarios which include the maximum discharge salinity have been modeled separately from the long term salinity modeling for evaluation purposes.



Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

Figure 4-20
Graphs of Baumberg 2C Operation Levels and Discharge Salinities

4.2.9.4 Management Operations

Baumberg System 2C will require active year round management because the intake pumping would be controlled by the discharge salinities at pond 2C. Active management will also be important in the transition period entering and exiting the summer management regime. The water surface elevations would be controlled primarily by the intake pump operations at ponds 6 and 1C and the discharge weir elevation at pond 2C.

Because of rainfall and low evaporation during the winter, winter pumping would typically not be required. However, limited pumping may be required during extreme drought winters with low rainfall. For winter operation, the discharge weir elevation at the 2C outlet structure would be set high enough (4.3 NGVD) to provide open water throughout the system. Winter operation pumping may be required to maintain water levels.

In the spring the system would be changed to the summer operation condition. The outlet weir would be lowered by approximately 1 foot (3.6 NGVD). This was assumed to occur in early May, but could vary depending on habitat conditions in the ponds. For example, the transition could be delayed or advanced based on use of the pond by migratory birds, or salinity levels in the ponds.

Lowering the discharge weir would lower the operating levels throughout the system and provide a significant increase in the gravity flow between ponds. The summer operation elevations would be similar to the existing operating elevations for downstream ponds. The new intake pump at pond 6 and the existing pump at pond 1C should have sufficient capacity to provide flow for salinity control during the spring, summer, and fall as needed. A proposed operation scheme was developed in which pumping would start if the discharge salinity exceeds 37 ppt, and stop if the discharge salinity is below 36 ppt. Because the discharge salinity responds slowly to the increased inflow, the pumps generally would operate for several days or weeks at a time. The pumping criteria could be modified to conform to other discharge goals such as a reduction in odors associated with pond drying.

A higher allowable salinity discharge goal would reduce the need for pumping. Based on the pond modeling for 1994 and 1995, the supplemental pumping would be necessary during summer periods with higher bay intake salinity, but may be significantly reduced during wet years with lower ambient salinity in the bay.

Ponds 1C and 5C would be a separate sub system within the overall system. Inflows from Alameda Flood Control Channel would be pumped as necessary to control salinity in the sub system. The sub system would discharge to pond 4C. This sub system may also be operated as a batch system with higher salinity to provide habitat for brine shrimp and related species. This may require additional analysis of pond salinities in pond 2C.

There are no salmonid migration concerns in Old Alameda Creek to limit pumped intake at pond 6, however there is the potential for future regulation of anadromous fish in Alameda Flood Control Channel.

4.2.10 Baumberg System 6A

The Baumberg System 6A consists of 3 ponds: ponds 8 (intake), 6B and 6A (outlet) as shown in Figure 4-19. The objectives for the system include:

- Establish ponds 8, 6B and 6A as seasonal or seasonally muted tidal pond (6A only)

- Manage for different water surface elevations summer vs. winter
  - Drain ponds in late spring for seasonal operation, or
  - Lower the water levels in late spring and allow muted tidal flow into pond 6A
  - Maintain open water during the winter

- Operate water levels lower than existing levels

- Maintain discharge salinity at levels below 40 ppt.

The proposed system includes:

- New 48" gravity intake at pond 8 from North Creek

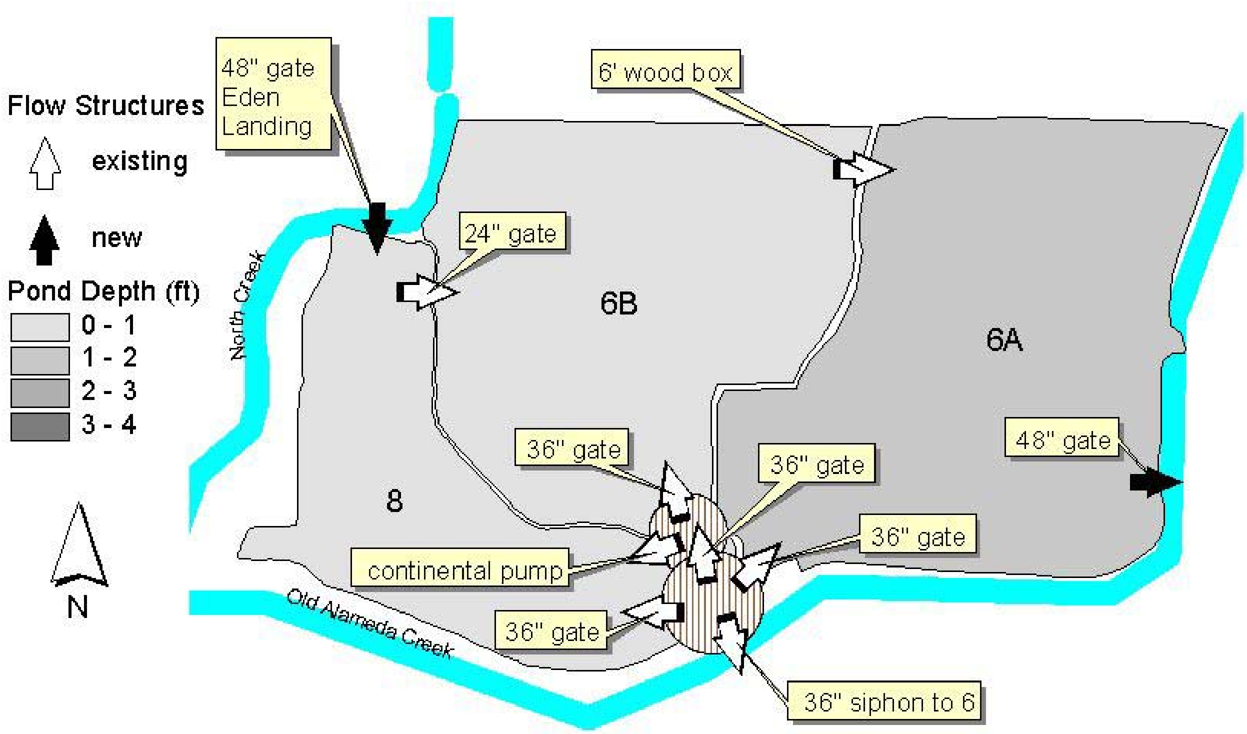
- Existing internal connection between
  - Pond 8 to 6B, two 36" gates
  - Ponds 6B and 6A, 6" box
  - Ponds 8 and 6A, 36" gate

- New 48" outlet with control weir at pond 6A into Old Alameda Creek

- Removal of existing continental pump

- Seal and abandon the siphon under Old Alameda Creek from pond 6A to 6

- Existing staff gage at all ponds



Note: Pond depths based on winter conditions.

Figure 4-21
Map of Baumberg 6A Inflow and Outflow Locations

4.2.10.1 Circulation Hydraulics

As a seasonal or muted tidal pond system, the system would not be subject to continuous circulation through ponds during the summer high evaporation season. The seasonal ponds would be filled during the fall to provide open water during the winter and early spring. The seasonal ponds would be drained in the spring. Due to the hydraulic limitations of the intake to pond 8 and the limited capacity of Old Alameda Creek, it was not considered practical to maintain continuous circulation in the 6A system during the summer.

Pond 6A may be operated as a muted tidal pond during the summer. With muted tidal operation, the outlet culvert would be opened to allow both inflow and outflow on each tidal cycle. The pond would then have a daily cycle of wetting and drying for part of the pond. Because of the limitation of the culvert and the creek channel, the daily tidal cycle within the pond would be relatively small, generally less than one foot. The tidal cycle in the bay is generally over six feet.

The intake and outlet structures and internal connections were designed to provide circulation for filling the pond system in the fall and to empty the ponds in the spring. The proposed intake structure into pond 8 at North Creek would include one 48" gravity culvert. All gravity intake flows would occur at high tide. The proposed intake structure would be constructed as part of the North Creek levee improvements to be completed as part of the Eden Landing restoration project.

In addition, the existing control structures include two control ponds located between the three ponds near Old Alameda Creek. The control ponds are shown in Figure 4-19, but not to scale. The actual ponds are each less than 1 acre. As shown in the plan, the south control pond (also called a donut) is connected by gated culverts to ponds 8 and 6A, to the north control pond and the siphon to pond 6 across Old Alameda Creek. The north control pond is connected to pond 6B. The north control pond was the source for water for the Continental pump, which pumped up into pond 8. For the salt making operations, the control ponds and pump were used to transfer water to and from pond 6. For the initial stewardship conditions, the pump and siphon would not be required. The system would be separate from the pond system south of Old Alameda Creek.

The system outlet structure would be located on the eastern end of pond 6A, and would discharge to Old Alameda Creek. All outflows would occur at low tide.

The initial stewardship conditions would include different operation plans for the ponds during the winter and summer seasons. The ponds would be seasonal and would have open water through the system during the winter. During the summer, the ponds would be dry or include a limited area of muted tidal area in pond 6A.

4.2.10.2 Interim Management Conditions

The inflow and outflow locations and graphs of pond operation levels and discharge salinities for the system are shown in Figures 4-19 and 4-20. Because the 6A system has been proposed for seasonal operation, only winter operation conditions are shown. The time scale shown is from November through June. Other systems which include summer operation show time scales from April 1994 through November 1995.

The estimated system flow rates using average daily flow and peak flows for both the intake and outlet are shown in Table 4.2.10.1, below. The summer conditions assume that all three ponds would be seasonal and dry during the summer. The winter conditions assume that there would be circulation through the system during the winter. The winter flows are controlled by the maximum tidal elevations in North Creek and the water surface elevation in pond 8.

Table 4.2.10.1
Baumberg System 6A Inflow and Outflow

Period	**Gravity Intake Flow**		**Discharge Flow**	
	Average	**Peak**	**Average**	**Peak**
Summer	-	-	-	-
Winter November - May	2 cfs 700 gpm	82 cfs 37,000 gpm	2 cfs 1,000 gpm	13 cfs 5,900 gpm

The predicted water surface elevations during the initial stewardship period are shown in Table 4.2.10.2.2, below.

Table 4.2.10.2.2
Baumberg System 6A Water Surface Elevations

Pond	Area (acres)	Bottom Elevation (ft NGVD)	Water Elevation (ft NGVD)		
			Existing	Interim Management	
				Summer	Winter
8	180	3.7	6.5	-	4.3
6B	284	2.1	3.0	-	3.0
6A	340	0.9	3.1	-	3.0
Total/ Average	804	2.	4.2	-	3.3

The starting conditions for the model were based on the ponds being empty at the beginning of the winter period. Therefore, the starting water surface elevations are at the bottom of the ponds and increase during the first months of the model. The water levels remain relatively constant during the winter, and then decrease during May when the ponds would be drained for the summer.

The water levels in pond 8 show some daily fluctuation, generally in the range of 0.3 to 0.5 ft. This is due to the relatively short intake period at high tide in comparison to the longer outlet period during the day when water would drain to ponds 6B and 6A. During this period, the water levels in pond 8 would be within the borrow ditch areas until 6A and 6B had been filled. The outlet flows would be controlled by the outlet weir at pond 6A.

4.2.10.3 Salinity

The estimated discharge salinity from pond 6A is shown in Figure 4-20. The salinity was estimated using the hydraulic model for the pond system. The initial pond salinity of 0 ppt assumed that there was no water in the ponds. This was based on the assumption that the ponds would be transferred dry and that there would be no initial release in April to drain the existing water in the ponds. If the ponds are transferred wet, additional analysis may be required to evaluate initial release discharges to Old Alameda Creek.

For the winter operation shown in Figure 4-20, the pond salinity would rapidly increase to match the intake salinity of approximately 25 ppt during the fall as the ponds fill. No actual discharge would occur during this period. In February when the ponds are full and begin to discharge, the salinity would begin to decrease due to rainfall within the system, and lower intake salinity from North Creek. The salinity for North Creek was assumed to be the same as the measured salinity in the bay at the Cargill Baumberg intake.

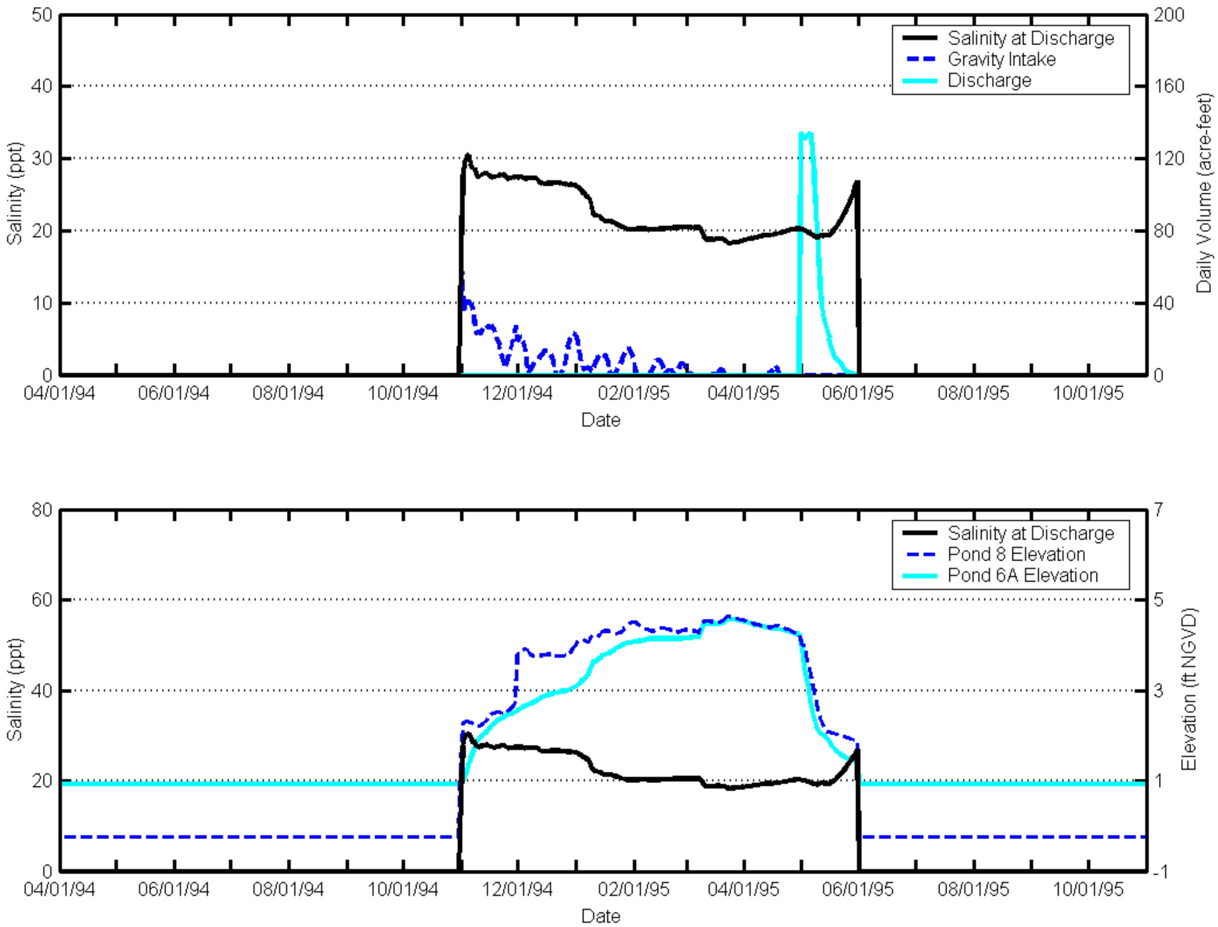
Pond 6A may be partially wet during the summer operation. The outlet structure at pond 6A could be opened to allow both inflow and outflow. The water level would be adjusted using the outlet weir to control the salinity in the pond. For lower water levels in the pond, the net daily inflow and outflow would increase to reduce the effect of evaporation within the pond. The lower pond elevation also reduces the wet area in the pond and therefore reduces the evaporation.

Table 4.2.10.3 shows the existing average summer and winter salinity levels based on recorded values for the past 5 years.

Table 4.2.10.3
Baumberg System 6A Existing Pond Salinity

Pond	Area (acres)	Average Pond Salinity (ppt)		Salinity Range (ppt)
		Summer	Winter	
8	180	138	110	48-299
6B	284	108	71	35-231
6A	340	94	63	32-184

System 6A includes salinity group 3 ponds and could have a maximum initial discharge salinity of 135 ppt. If the salinity in the system were at the maximum at the start of bay water circulation, the discharge salinity would start at 135 ppt and the discharge would decrease in a few months as the ponds drain. Additional modeling analysis may be required to evaluate alternative initial release discharges to Old Alameda Creek.



Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

Figure 4-22
Graphs of Baumberg 6A Operation Levels and Discharge Salinities

4.2.10.4 Management Operations

Baumberg System 6A will require limited active management, primarily during the transitions to and from the winter operation conditions. Pond water surface elevations would be controlled primarily by adjusting the control gates at the intake and outlet, between ponds. Intake salinities would be the similar to the bay salinity and pond salinities would be similar to existing bay salinities.

For the winter operation, the gates from pond 6B to pond 6A would be open to equalize the water surface elevations within the ponds. Water from the bay would circulate from pond 8 to 6B and 6A. Pond 8 would operate at a higher elevation because the pond bottom is higher. The water level in pond 8 may be controlled by a weir at the discharge, or by adjustment of the pond 8 control gates.

In the spring the system would be drained for the summer condition. This was assumed to occur in early May, but could vary depending on habitat conditions in the ponds. For example, the transition could be delayed or advanced based on use of the pond by migratory birds, or salinity levels in the ponds.

Because ponds would be operated as seasonal ponds, the ponds would slowly drain and dry during the late spring, and no further management would be required until winter. The ponds would then become part of the continuous flow operation in winter.

If pond 6A is to be operated as a muted tidal pond during the summer, the outlet culvert would be opened to allow inflow and outflow and the water level would be controlled by the outlet weir. Without the outlet weir the pond would only contain minimal water at extreme high tides.

4.2.11 Baumberg System 8A

The Baumberg System 8A consists of 6 ponds: ponds 9 (intake), 8x and 8A (outlet) and seasonal ponds 12, 13 and 14, as shown in Figure 4-21. The objectives for the system include:

- Establish tidal circulation through ponds 9 and 8A
- Allow portions of 8A to dry-down in summer
- Establish ponds 12, 13, and 14 as seasonal ponds or winter batch ponds
- Manage for different water surface elevations summer vs. winter
  Summer water elevations lower than winter elevations to increase gravity inflow
- Operate water levels lower than exiting levels
- Maintain discharge salinity at levels below 40 ppt
- Allow reversal of intake and outlet flow to better maintain constant water levels, drain ponds after storm events, or serve as a contingency should gates fail.

The proposed system would include:

- New 4x48” gated intake at pond 9 from Mount Eden Creek

- Existing internal connections from
  Pond 13 to 14, 2x42" wood gates
  Pond 14 to 9, 2x58" wood gates
  Pond 9 to 8A, 42" pipe and 48" gate

- Existing multiple levee gaps between pond 12 and 13 (abandoned levee)

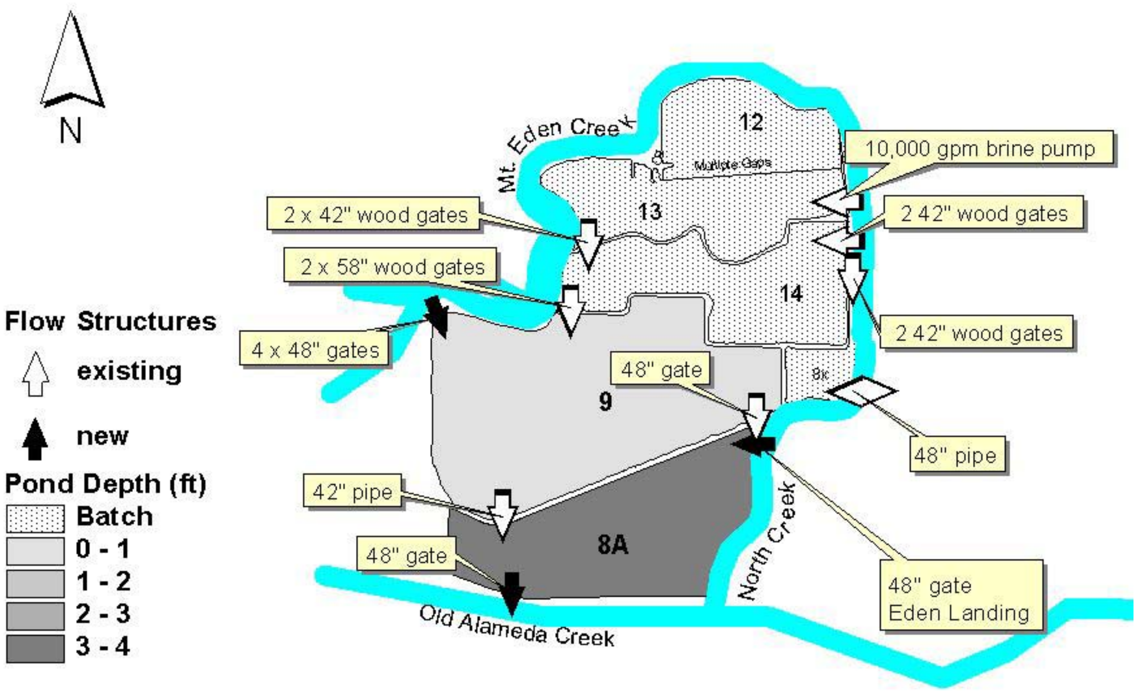
- Existing 10,000 gpm brine pump at pond 13 would be used as an intake pump from pond 8x or from Mount Eden Creek extension to pond 13

- Modify connections from pond 9 to 8A to include fixed weirs

- New 48" outlet at pond 8A into Old Alameda Creek

- New 48" intake gate at 8A from North Creek (part of Eden Landing Ecological Reserve Restoration project)

- Existing staff gages in all ponds



Note: Pond depths based on winter conditions.

Figure 4-23
Map of Baumberg 8A Inflow and Outflow Locations

4.2.11.1 Circulation Hydraulics

All four culverts of the pond 9 intake structure at Mount Eden Creek would include operable gates and flapgates to allow inflow. However two culverts would include gates to allow outflow, if necessary. Controls to allow outflow at the intake structure are included to maintain management flexibility and allow discharge from pond 9 in the event of flooding or a gate failure within the system. A 48” intake gate has been constructed at the northeasterly end of pond 8A as part of the Eden Landing restoration project. The pond 8A intake would increase circulation within pond 8A.

The outlet structure from pond 8A would include operable gates and flapgates to close off all flow or allow outflow only or allow inflow and outflow. The control gates at the intake and outlet culverts would allow partial culvert openings to control water levels. All gravity intake flow would occur at high tide, and all outflows would occur at low tide.

The operating water levels in the ponds would be lower during the summer to increase the gravity inflow into the system during the higher evaporation season. The water level in pond 9 would be approximately 3.4 ft NGVD during the summer, and 4.6 ft NGVD during the winter. The minimum water level in pond 9 would be controlled by fixed weirs at the connections to pond 8A. The fixed weirs would not be adjustable using weir boards. Because of the high bottom elevations in pond 8A, it would be only partially wet during the summer.

The existing brine pump at pond 13 will remain to provide inflows to the seasonal ponds 12, 13, and 14. The pump will intake from pond 8x or from the extension of Mount Eden Creek. The Mount Eden Creek extension will be constructed as part of the Eden Landing restoration project. Inflows to pond 8x will use the existing intake from North Creek. Because of the high bottom elevation in pond 8x, only the borrow ditches will be wet for normal tidal conditions. The ditches will be used to transport inflow from North Creek to the pump at pond 13.

4.2.11.2 Interim Management Conditions

The system structure location map and graphs of pond operation flows, water levels and discharge salinities for the Baumberg System 8A are shown in Figures 4-21 and 4-22.

The estimated system flow rates using average daily flow and peak flows for both the intake and outlet are shown in Table 4.2.11.2.1, below.

Table 4.2.11.2.1
Baumberg System 8A Inflow and Outflow

Period	**Gravity Intake Flow**		**Discharge Flow**	
	Average	**Peak**	**Average**	**Peak**
Summer May - October	38 cfs 17,000 gpm	420 cfs 190,000 gpm	35 cfs 7,400 gpm	88 cfs 40,000 gpm
Winter November - April	4 cfs 1,600 gpm	306 cfs 140,000 gpm	4 cfs 1,800 gpm	7 cfs 2,900 gpm

The predicted water surface elevations during the initial stewardship period are shown in Table 4.2.11.2.2, below.

Table 4.2.11.2.2
Baumberg System 8AWater Surface Elevations

Pond	Area (acres)	Bottom Elevation (ft NGVD)	Water Elevation (ft NGVD)		
			Existing	Initial Stewardship	
				Summer	Winter
9	356	2.6	4.7	3.4	4.6
8A	256	4.0	4.6	2.0	4.5
12	99	2.9	4.8	-	4.0
13	132	3.1	4.6	-	4.0
14	156	3.5	4.7	-	4.0
Total/ Average	1,008	3.0	4.7	3.4	4.2

The starting conditions for the model were based on water surface elevations and salinity levels in April 2002 to include the potential initial release conditions at the start of the circulation operations in ponds 9 and 8A. Therefore, the starting water surface elevations are similar to winter operation levels and are reduced during May to the summer operation levels.

The water levels in pond 8 show more daily fluctuation than other ponds including other outlet ponds. To increase circulation in pond 8A, the outlet was assumed to be fully open during the summer to increase circulation. The daily fluctuation in pond 8A with tidal inflow from both Old Alameda Creek and North Creek was estimated to be approximately 0.60 ft or less. However, during the summer only the borrow ditch areas would be affected. This represents approximately 10 percent of the entire pond area. There may also be some additional low areas from historic sloughs within the pond bottom, which may also be affected.

The water levels in ponds 9 and 8A would be lower during the summer for the initial stewardship conditions than for existing conditions. The initial stewardship conditions were designed to maintain a minimum average depth of 1.0 ft in pond 9 during the summer and 1.0 ft in pond 8A during the winter. Pond 8A would generally be dry during the summer operation, with circulation flows in the borrow ditches.

4.2.11.3 Salinity

The estimated discharge salinity from pond 8A to Old Alameda Creek is shown in Figure 4-22. The model results are shown for the entire simulation period from April 1994 to October 1995. The model simulation period includes a dry year and a wet year to evaluate discharge salinities for a range of summer operation conditions.

The initial pond salinities and water surface elevations were based on measured conditions in early April 2002. The pond system transitions from the initial starting conditions in the first 4 to 6 weeks of operation.

Table 4.2.11.3
Baumberg System 8A Existing Pond Salinity

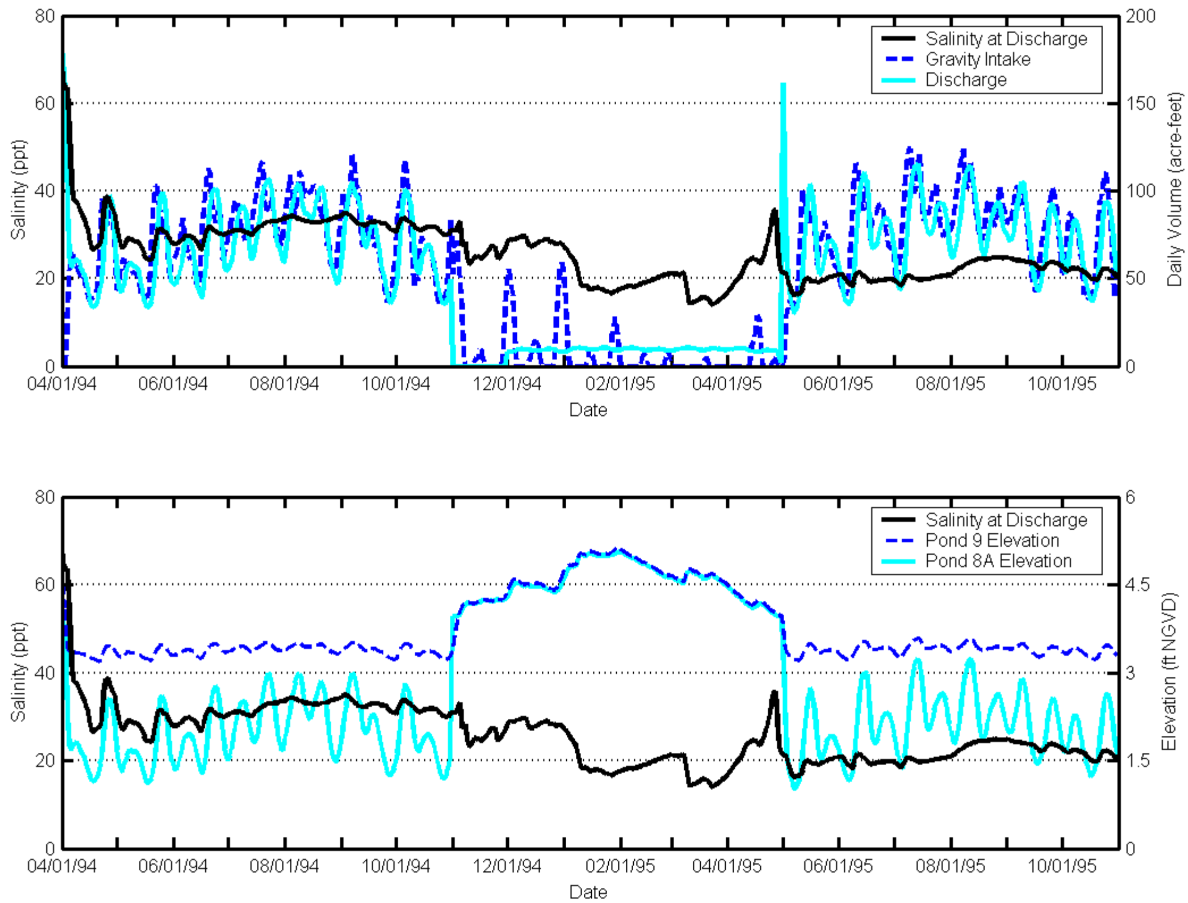
Pond	Area (acres)	Average Pond Salinity (ppt)		Salinity Range (ppt)
		Summer	Winter	
9	356	149	111	62-279
8A	256	159	118	69-285
12	99	107	81	27-328
13	132	99	81	27-334
14	156	124	91	32-304

It should be noted that all of the ponds in the system are operated as batch ponds for the existing salt making operations. This means that large volumes of water are transferred from pond to pond during relatively short periods of time rather than continuous flow during the evaporation season. Therefore, the salinity in each pond can change significantly from month to month and year to year. In addition, during 2001 and 2002 the operations were affected by construction for North Creek and the Eden Landing restoration. Salinity levels in the system were higher than in previous years.

Ponds 12, 13, and 14 were not included in the continuous operation model for the system. These ponds would operate as seasonal or batch ponds. As seasonal ponds, the ponds would contain rainwater during the winter, and generally be dry during the summer. The pond salinity would not be controlled, but would fluctuate due to residual salt in the pond, rainwater inflows, and seasonal evaporation.

As batch ponds, the ponds may be filled with bay water from North Creek during the fall using the pump from pond 8x. The salt water would remain in the ponds during the winter and discharged to pond 9 in the spring. Additional inflows could be added during the winter to control the salinity in the batch ponds. This type of batch operation would allow different winter habitat conditions in ponds 12, 13, and 14 than the seasonal operation, with higher salinity and more consistent water levels.

System 8A includes salinity group 3 ponds and would have a maximum initial discharge salinity of 135 ppt. If the salinity in the system were at the maximum at the start of bay water circulation, the discharge salinity would start at 135 ppt and decrease to be similar to the modeled conditions in Figure 4-22 in a few months. Initial release scenarios which include the maximum discharge salinity have been modeled separately from the long term salinity modeling for evaluation purposes.



Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

Figure 4-24
Graphs of Baumberg 8A Operation Levels and Discharge Salinities

4.2.11.4 Management Operations

Baumberg System 8A will require limited active management, primarily during the transitions to and from the summer operation conditions, as well as winter management of ponds 12, 13, and 14 if they are operated as batch ponds.

For the winter operation, the gates from pond 9 to pond 8A would be open. Water from the bay would circulate from pond 9 to 8A. The outlet control gates from pond 8A would be set to control the water levels in ponds 8A and 9.

In the spring the system would be changed to the summer operation condition. This was assumed to occur in early May, but could vary depending on habitat conditions in the ponds. For example, the transition could be delayed or advanced based on use of the pond by migratory birds, or salinity levels in the ponds.

For the summer operation, the inlet and outlet structures at pond 8A should be open for muted tidal inflow and outflow. The water level in pond 9 would be controlled by the fixed weirs between pond 9 and pond 8A.

Based on modeling of the system for historic tide and evaporation conditions in 1994, the gravity intake system would be sufficient to maintain the maximum salinity goals during periods of weak tides. Weak tide periods are the portion of the lunar cycle with higher low tides and lower high tides. Gravity inflows would only occur at high tide levels in the bay. During periods of weak tides, with lower high tides, the inflow may be reduced. Weak tide periods may extend for a week to 10 days. A sensitivity analysis was prepared to evaluate the potential effects of extreme high evaporation combined with weak tides. The 1994 weak tide summer period was rerun using evaporation values 20 percent higher than normal. This corresponds to an evaporation condition with approximately a 25-year recurrence interval. This means that on average, it would be exceeded once in a 25-year period.

Ponds 12, 13, and 14 would be operated as seasonal or winter batch ponds. For seasonal pond operations, the pond would be drained initially and no further operation would be required. The pond would fill with 10 to 20 inches of rainwater during the winter that would evaporate during the summer.

As batch ponds, ponds 12, 13, and 14 would not have continuous flow operation similar to 9 and 8A. All inflows to 12, 13, and 14 must be pumped from pond 8x and North Creek. Water would be pumped from 8x in the fall to establish an operational water level in the ponds. Supplemental water may be added during the winter to maintain water levels in dry years. In wet years, surplus water may be released from pond 14 to pond 9 to limit the maximum water level in the ponds. Depending on weather conditions, the batch operation may require gate adjustment weekly or more frequently. If the salinity in ponds 12, 13 and 14 begins to increase in the spring the ponds may require additional inflows to control the salinity. In general, the batch ponds would be drained to pond 9 in the spring to minimize the pumping required for salinity control in the seasonal ponds during the summer high evaporation season.

4.2.12 Baumberg System 11

The Baumberg System 11 consists of ponds 10 (intake and outlet) and pond 11 (outlet) as shown in Figure 4-23. The objectives for the system include:

- Establish tidal circulation through ponds 10 and 11
- Establish pond 11 as a seasonal or muted tidal pond

- Manage for different water surface elevation levels summer vs. winter
  Summer water elevations lower than winter elevations to increase gravity inflow

- Operate water surface levels lower than existing levels

- Maintain discharge salinity at levels below 40 ppt

- Locate intake to minimize disturbance to tidal marsh habitat

- Allow reversible flow at new intake and outlet structures.

The system includes:

- New 4x48” gravity intake structure at pond 10 from lower Mount Eden Creek (to replace the existing intake structure from the San Francisco Bay)

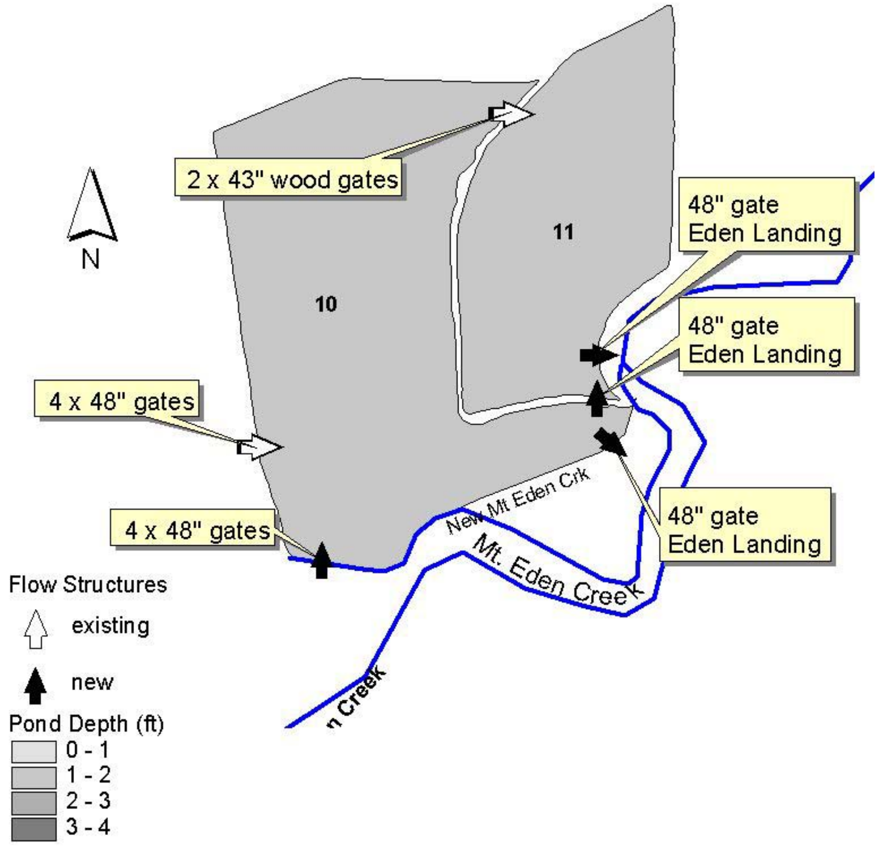
- Existing 2x43” wood gates between ponds 10 and 11

- New 48” gate between ponds 10 and 11

- New 48” gravity outlet structures with control weir Mt. Eden Creek at
  Pond 10
  Pond 11 (both are part of Eden Landing restoration project)

- Remove existing gates from ponds 10 and 11 to the brine ditch at Mount Eden Creek (part of the Eden Landing restoration project)

- Existing staff gages at both ponds



Note: Pond depths based on winter conditions.

Figure 4-25
Map of Baumberg 11 Inflow and Outflow Locations

4.2.12.1 Circulation Hydraulics

This pond group would contain two continuous circulation ponds: 10 & 11. The system has different operation plans for winter and summer seasons to meet summer evaporation conditions. The intake and outlet structures and internal connections were designed to provide circulation for water quality control during the summer evaporation season and allow seasonal flow through pond 11. All four intake gates would allow tidal inflow to pond 10. Two of the culverts would include control gates to allow outflow at the intake structure. All gravity intake flows would occur at high tide. The proposed intake structure would replace an existing intake structure from San Francisco Bay into pond 10. The replacement has been proposed due to the age and condition of the existing intake. The new location has been proposed to improve flow conditions at the intake. The existing intake is located in a large marsh area with tidal action only at high tide. The proposed location would be in an area of lower Mount Eden Creek with less marsh area.

A new 48” gate would be installed between ponds 10 & 11 at the southern end of pond 11. This additional internal connection would supplement existing inflows to pond 11 from pond 10 via two 43” wood gates located in the northern half of the ponds.

There are existing wooden gates from ponds 10 and 11 to a brine ditch on the west side of Mount Eden Creek that would be removed. The brine ditch has been used to transfer water for the commercial salt operation. The ditch connected ponds 10 and 11 with the existing brine pump at pond 13. The brine ditch and the existing gates to the brine ditch will be removed as part of Mount Eden Creek improvements for the Eden Landing Salt Pond Restoration project.

Two outlet structures, one on the eastern end of pond 10 and the other on the southeastern end of pond 11, would discharge to Mount Eden Creek. The outlet structures would both consist of a single 48” culvert. All outflows would occur at low tide. The outlet culverts would be constructed as part of the Mount Eden Creek improvements for the Eden Landing restoration project to replace the existing wooden gates and the existing brine ditch.

The initial stewardship conditions would include different operation plans for each pond during the winter and summer seasons. The operating water levels in the ponds would be lower during the summer to increase the gravity inflow into the system during the higher evaporation season. The water level would be approximately 3.1 ft NGVD during the summer, and 4.0 ft NGVD during the winter. Because of the high bottom elevations in pond 11, it would be only partially wet during the summer. Therefore, pond 11 would be closed off from pond 10 and pond 11 would be operated as a muted tidal or seasonal pond during the summer. Pond 10 would discharge directly to Mt. Eden Creek during the summer.

During the winter, the circulation pattern would be from pond 10 to pond 11, then to Mount Eden Creek. The control gates would be adjusted to maintain higher water levels and create open water habitat in both ponds. Pond 11 would discharge into Mt. Eden Creek during the winter.

4.2.12.2 Interim Management Conditions

The system structure location map and graphs of pond operation flows, water levels and discharge salinities for the Baumberg System 11 are shown in Figures 4-23 and 4-24.

The estimated system flow rates using average daily flow and peak flows for both the intake and outlet are shown in Table 4.2.12.2.1, below.

Table 4.2.12.2.1
Baumberg System 11 Inflow and Outflow

Period	**Gravity Intake Flow**		**Discharge Flow**	
	Average	**Peak**	**Average**	**Peak**
Summer	28 cfs 13,000 gpm	348 cfs 156,000 gpm	26 cfs 12,000 gpm	70 cfs 31,000 gpm
Winter	11 cfs 4,900 gpm	318 cfs 144,000 gpm	12 cfs 5,200 gpm	65 cfs 29,000 gpm

The predicted water surface elevations during the initial stewardship period are shown in Table 4.2.12.2.2, below. Note that Ponds 11 becomes seasonal after one month.

Table 4.2.12.2.2
Baumberg System 11 Water Surface Elevations

Pond	Area (acres)	Bottom Elevation (ft NGVD)	Water Elevation (ft NGVD)		
			Existing	Interim Management	
				Summer	Winter
10	214	2.4	3.8	3.1	4.0
11	118	2.9	4.3	-	4.0
Total/ Average	332	2.6	4.0	3.1	4.0

The starting conditions for the model were based on water surface elevations and salinity levels in April 2002 to include the potential initial release conditions at the start of the circulation operations in ponds 10 and 11. Therefore, the starting water surface elevations are similar to winter operation levels and are reduced during May to the summer operation levels.

The water levels in pond 10 some daily fluctuation, generally in the range of 0.2 to 0.3 ft. This is due to the relatively short intake period at high tide in comparison to the longer outlet period at low tide. The outlet flows would be controlled by the outlet control gate at pond 10.

The water levels in ponds 10 and 11 would be lower during the summer for the initial stewardship conditions than for existing conditions. The initial stewardship conditions were designed to maintain a minimum average depth of 0.70 ft in pond 10 during the summer, and 1.60 ft in pond 10 during the winter. Pond 11 would generally be dry during the summer operation, and would contain approximately 1.0 ft of water during the winter.

4.2.12.3 Salinity

The estimated discharge salinity from pond 10 or 11 to Mount Eden Creek is shown in Figure 4-24. The model results are shown for the entire simulation period from April 1994 to October 1995. The model simulation period includes a dry year and a wet year to evaluate discharge salinities for a range of summer operation conditions.

The initial pond salinities and water surface elevations were based on measured conditions in early April 2002. The pond system transitions from the initial starting conditions in the first 4 to 6 weeks of operation.

Pond 11 would be drained in the late spring and remain dry during the summer high evaporation season. The model analysis assumed that pond 11 would be drained in May and filled in November.

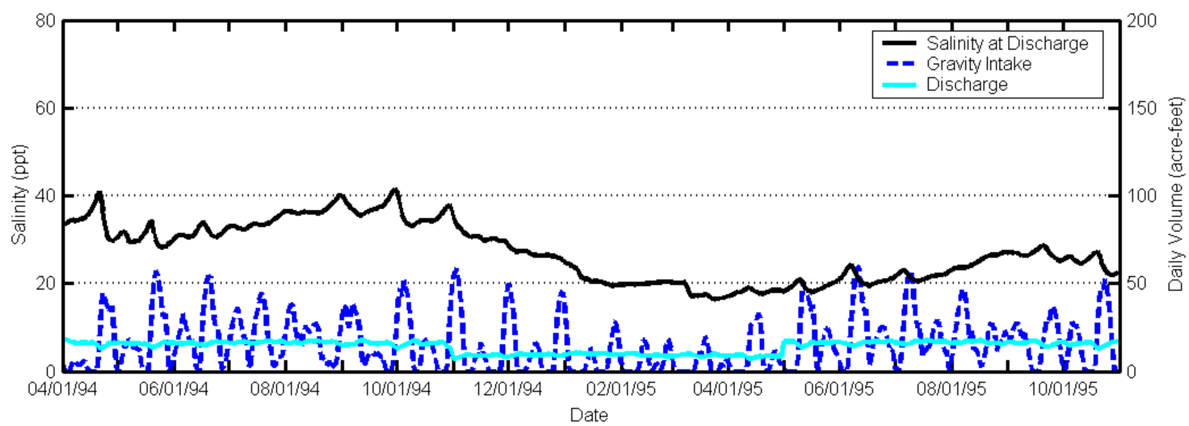
Pond 11 was not included in the continuous operation model for the system during the summer. The pond would operate as a muted tidal or seasonal pond in summer. As a seasonal pond, it would generally be dry during the summer. The pond salinity would be controlled by the control gate opening and the balance between evaporation and the daily inflow and outflow.

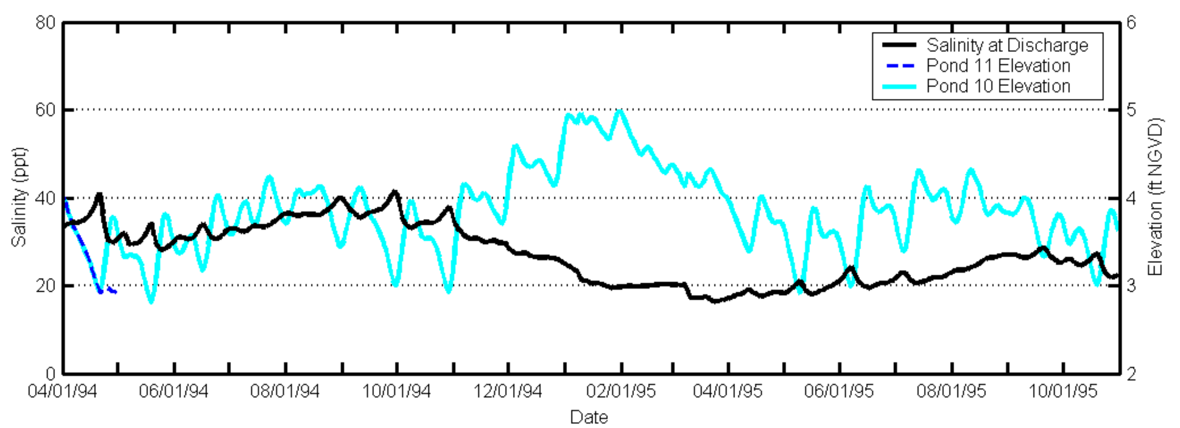
Table 4.2.12.3 shows the existing average summer and winter salinity levels based on values recorded for the past 5 years.

Table 4.2.12.3
Baumberg 11System Existing Pond Salinity

Pond	Area (acres)	Average Pond Salinity (ppt)		Salinity Range (ppt)
		Summer	Winter	
10	214	37	27	16-74
11	118	47	32	16-81

System 11 includes salinity group 1 ponds and could have a maximum initial discharge salinity of 65 ppt. If the salinity in the system were at the maximum at the start of bay water circulation, the discharge salinity would start at 65 ppt and decrease to be similar to the modeled conditions in Figure 4-24 in a few months. Initial release scenarios which include the maximum discharge salinity have been modeled separately from the long term salinity modeling for evaluation purposes.





Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

Figure 4-26
Graphs of Baumberg 11 Operation Levels and Discharge Salinities

4.2.12.4 Management Operations

Baumberg System 11 will require active management, primarily during the transitions to and from the summer operation conditions. Water surface elevations would be primarily controlled by adjusting the outlet control gates. Intake salinities would be the same as bay salinities and pond salinities would be similar to existing bay salinities.

For the winter operation, the gates from pond 10 to pond 11 would be open. Water from the bay would circulate from pond 10 to 11. The control gates at the outlet structures from ponds 10 and 11 would be set to provide open water throughout the system.

In the spring the system would be changed to the summer operation condition. This was assumed to occur in early May, but could vary depending on habitat conditions in the ponds. For example, the transition could be delayed or advanced based on use of the pond by migratory birds, or salinity levels in the ponds.

For the summer operation, the pond 10 outlet gate would be adjusted to lower the pond water level by approximately 1.0 feet. This would provide a significant increase in the gravity inflow from the intake culverts in pond 10. The internal connections between ponds 10 and 11 would be closed so that pond 11 would be operated as a seasonal pond or muted tidal pond.

Based on modeling of the system for historic tide and evaporation conditions in 1994, the gravity intake system would be sufficient to maintain the maximum salinity goals during periods of weak tides. Gravity inflows would only occur at high tide levels in the bay. During periods of weak tides, with lower high tides, the inflow may be reduced. Weak tide periods may extend for a week to 10 days. A sensitivity analysis was prepared to evaluate the potential effects of extreme high evaporation combined with weak tides. The 1994 weak tide summer period was rerun using evaporation values 20 percent higher than normal. This corresponds to an evaporation condition with approximately a 25-year recurrence interval. This means that on average, it would be exceeded once in a 25-year period. The estimated inflow from the gravity intake culverts would maintain the discharge salinity below approximately 40 ppt.

Because pond 11 would be operated as muted tidal or seasonal pond, the pond would slowly drain and dry up over summer and no further management would be required until winter. The pond would then become part of the continuous flow operation in winter. If pond 11 is to be operated as a muted tidal pond during the summer, the outlet culvert would be opened to allow inflow and outflow and the water level would be controlled by the outlet weir. Without the outlet weir the pond would only contain minimal water at extreme high tides.

4.2.13 West Bay Complex Ponds

The West Bay pond group consists of five pond systems. The complex includes seven ponds: 1, 2, 3, 4, 5, S5 and SF2. The West Bay pond group is shown in Figure 4-25. The objectives for the system include:

- Establish tidal circulation through ponds 1, 2, 3, 4, 5 and S5
- Maintain discharge salinity at levels below 40 ppt
- Locate intakes to minimize disturbance to tidal marsh habitat
- Allow reversible flow at new intake/outlet structures

The system includes:

- New gravity intake/outlet structures:

  48” culvert, pond 1 to Ravenswood Slough
  2x48” culverts, pond 2 to Ravenswood Slough
  2x48” culverts, pond 3 to Ravenswood Slough
  3x48” culverts, pond 4 to Westpoint Slough
  48” culvert, pond S5 to Flood Slough Restoration Area
  3x48” culverts, pond SF2 to San Francisco Bay

- Existing 2x60” intake at pond 1

- Seal and abandon existing 36” siphon from pond 2 to SF2

- Existing pond connections:

  2x42” wood gates from pond 2 to 1
  30” siphon from pond 3 to 2
  36” wood gate from pond 3 to S5
  2x36” wood gates from pond S5 to 5
  Gap between pond 5 and 4
  Ravenswood pump and siphon from pond 1

- Existing staff gages at all ponds.

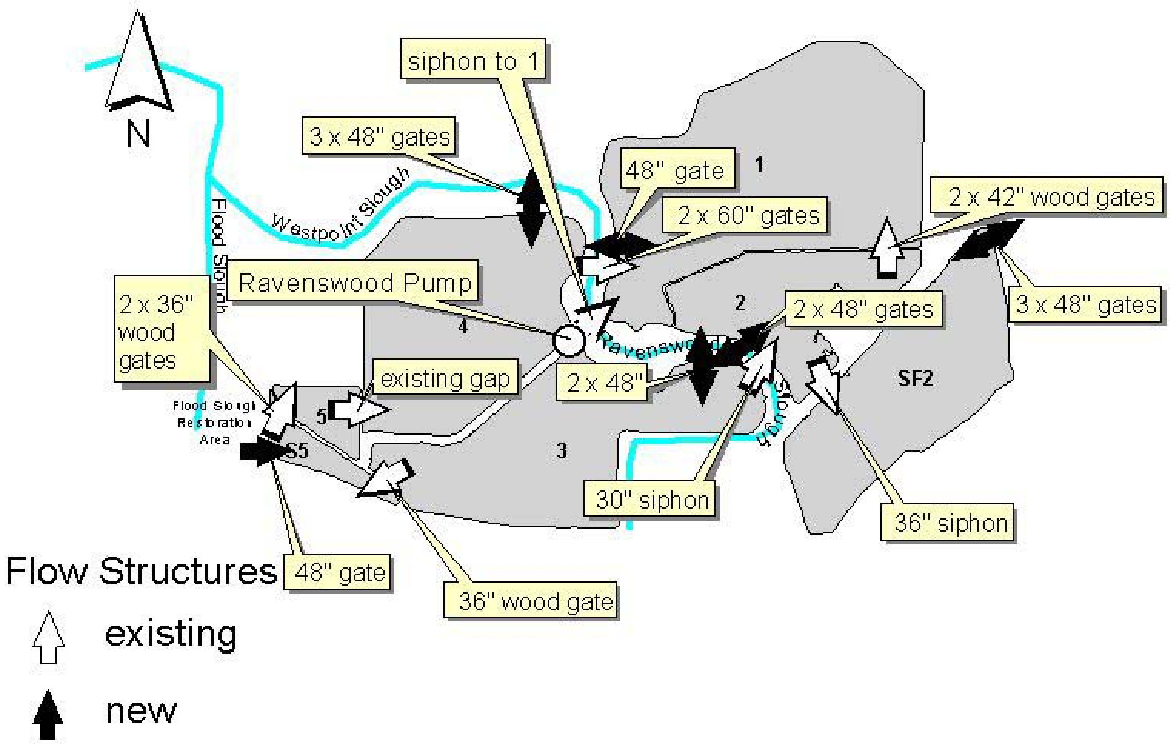


Figure 4-27
Map of West Bay Complex Inflow and Outflow Locations

4.2.13.1 Circulation Hydraulics

The West Bay pond group would contain five separate sub systems. Ponds 1, 2, 3, and SF2 would each be an independent single pond system with inlet/outlet structures. The inlet/outlet structures would allow tidal inflow at high tide and outflow at low tide. The intake/outlet structures were designed to provide circulation for water quality control during the summer evaporation. All gravity intake flows would occur at high tide, and all outflows would occur at low tide. The proposed intake/outlet structures were located minimize construction within the existing marsh areas along the bay and slough levees.

The other west bay pond group would include S5 (inlet), 5, and 4 (inlet/outlet). The major flow to the system would be from the pond 4 intake. There would be a supplemental intake structure to provide circulation from the Flood Slough Restoration Area west of pond S5. The supplemental intake would provide circulation through both ponds S5 and 5.

4.2.13.2 Interim Management Conditions

The system structure location map and graphs of pond operation flows, water levels and discharge salinities for the West Bay pond group are shown in Figures 4-25 and 4-26.

The estimated system flow rates using average daily flow and peak flows for both the intake and outlet are shown in Table 4.2.13.2.1, below.

Table 4.2.13.2.1
West Bay Pond Systems Inflow and Outflow

Pond System	Gravity Intake Flow		Discharge Flow	
	Average	Peak	Average	Peak
1	34 cfs 15200 gpm	318 cfs 142600 gpm	33 cfs 14800 gpm	100 cfs 44700 gpm
2	25 cfs 9600 gpm	201 cfs 90100 gpm	24 cfs 9000 gpm	74 cfs 31800 gpm
3	21 cfs 1100 gpm	196 cfs 88200gpm	21 cfs 1100 gpm	71 cfs 46500 gpm
Pond 4	18cfs 8200 gpm	204 cfs 118500 gpm	18 cfs 8200 gpm	75 cfs 33600gpm
SF2	22cfs 9900 gpm	274 cfs 122800 gpm	22 cfs 9900 gpm	97 cfs 43700 gpm

The predicted water surface elevations during the initial stewardship period are shown in Table 4.2.13.2.2, below.

Table 4.2.13.2.2
West Bay Pond Systems Water Surface Elevations

Pond	Area (acres)	Bottom Elevation (ft NGVD)	Water Elevation (ft NGVD)		
			Existing	Interim Management	
				Summer	Winter
1	445	2.1	2.6	3.0	3.1
2	145	2.0	3.5	2.8	2.8
3	273	2.2	3.4	2.9	3.0
4	297	2.8	3.2	3.5	3.5
5	31	2.5	3.1	3.5	3.5
S5	29	2.5		3.7	3.7
SF2	242	2.6	3.6	3.3	3.4
Total/ Average	1462	2.4	3.2	3.3	3.3

The starting conditions for the model were based on water surface elevation levels in April 2002 to include the potential initial release conditions at the start of the circulation operations in the West Bay ponds. The starting water surface elevations are higher than the proposed operation levels and therefore water levels would decrease during the first month of operation. On average, the initial stewardship conditions in the West Bay ponds would be approximately 0.1 ft higher than the than the historic conditions in the ponds. For ponds 1, 4 and 5 the ISP conditions would be higher. For ponds 2, 3, and SF2 the ISP conditions would be lower. There are no existing water level records for pond S5.

The outlet flows would be controlled by an outlet weir at each pond outlet or using the culvert control gates. The weir may be necessary to maintain minimum water levels during low tides. The average bottom elevation in the west bay ponds is approximately 2.4 feet above mean tide elevation.

4.2.13.3 Salinity

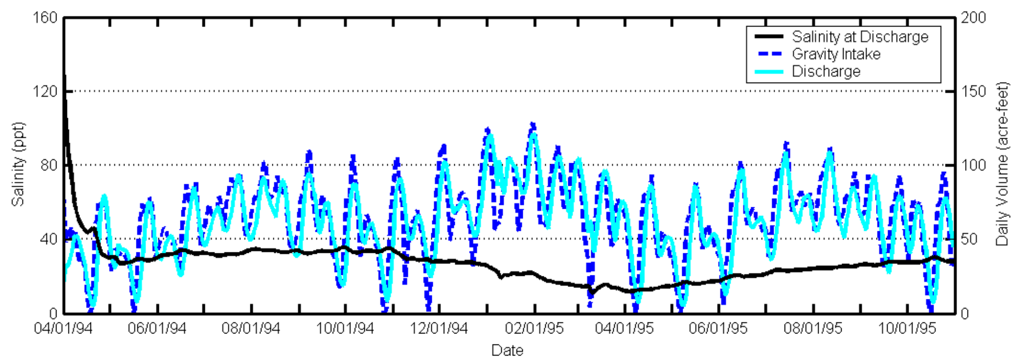
The estimated discharge salinity from the West Bay ponds system is shown in Figures 4-27, 4-28, and 4-29. The model results are shown for the entire simulation period from April 1994 to October 1995. The model simulation period includes a dry year and a wet year to evaluate discharge salinities for a range of summer operation conditions.

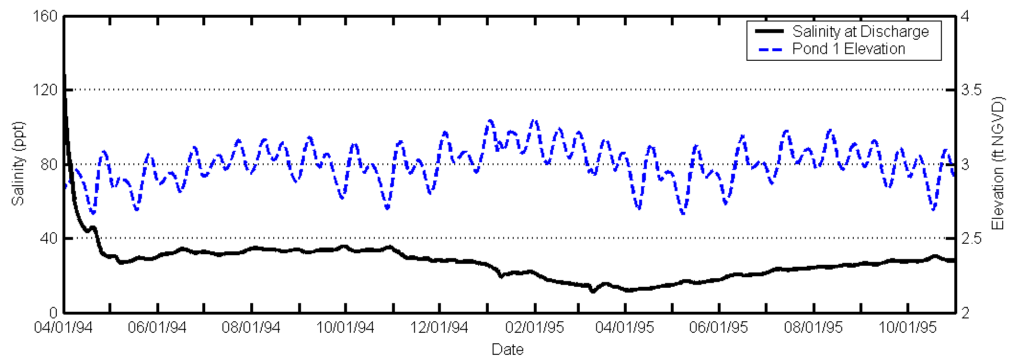
The initial pond salinities and water surface elevations were based on measured conditions in early April 2002. The pond system transitions from the initial starting conditions in the first 4 to 6 weeks of operation.

Table 4.2.13.3 shows the existing average summer and winter salinity levels based on values recorded for the past 6 years. There are no recorded salinities for pond S5.

Table 4.2.13.3
West Bay Pond Systems Existing Pond Salinity

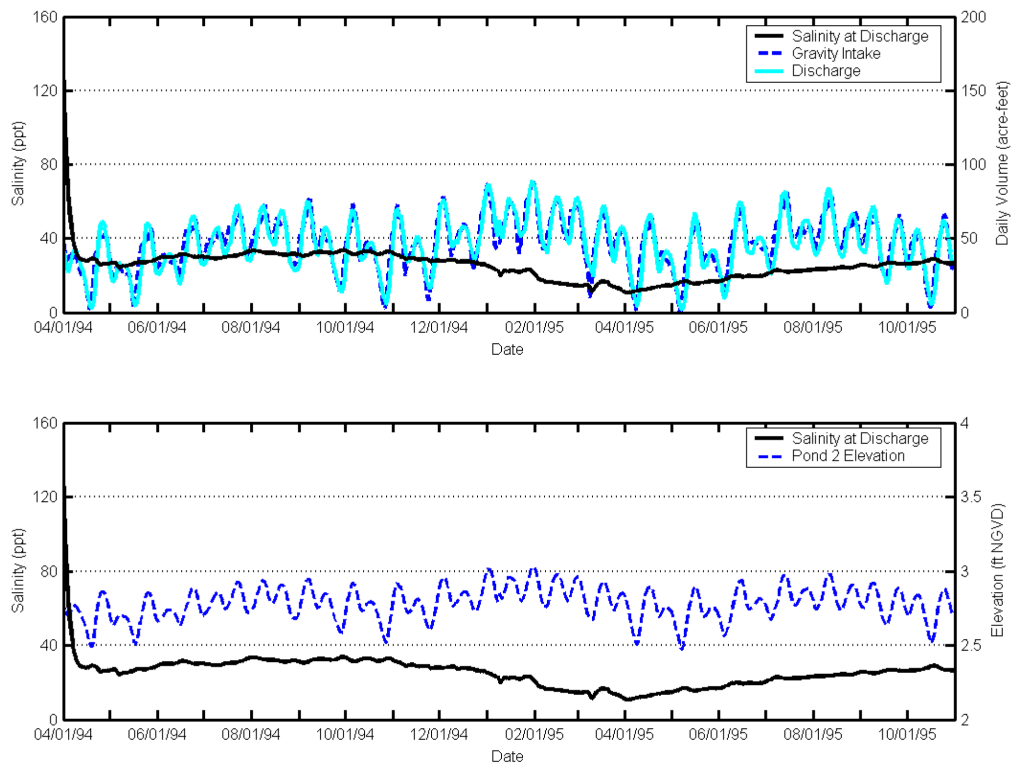
Pond	**Area (acres)**	**Average Pond Salinity (ppt)**		**Salinity Range (ppt)**
		Summer	**Winter**	
1	445	150	130	35-326
2	145	211	176	64-306
3	273	244	191	145-320
4	297	276	198	88-341
5	31	274	200	96-340
S5	29			
SF2	242	202	157	76-316





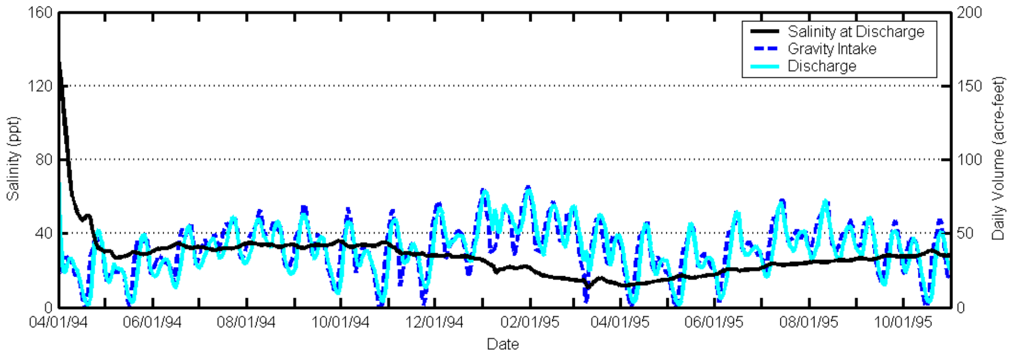
Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

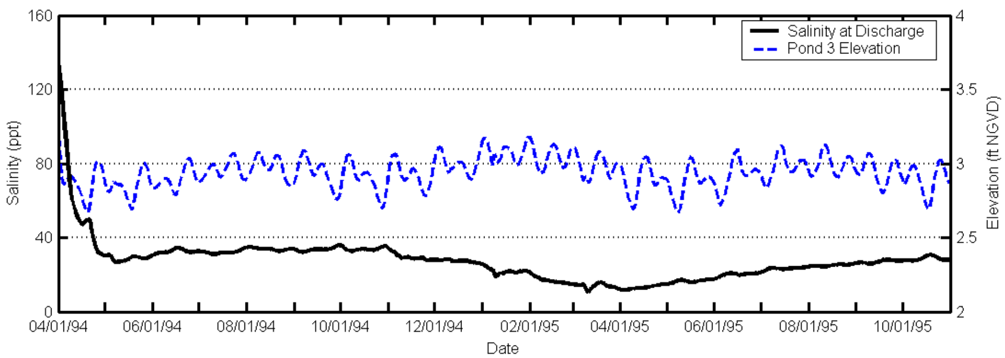
Figure 4-28
Graph of West Bay 1 Discharge Salinities



Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

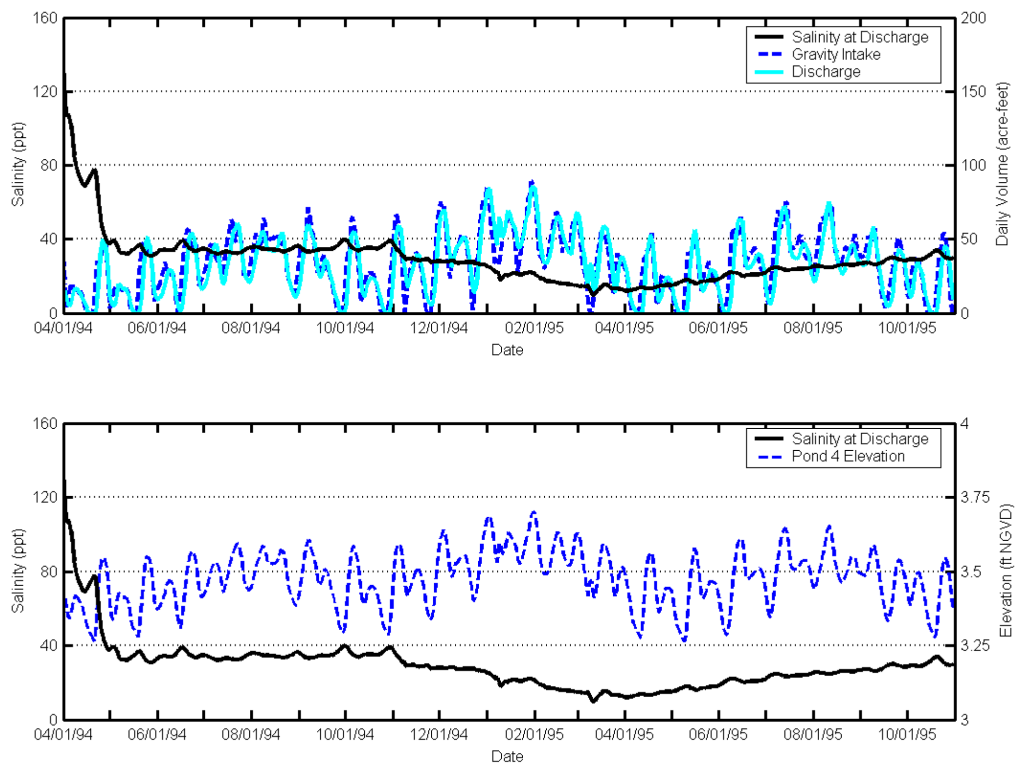
Figure 4-29
Graph of West Bay 2 Discharge Salinities





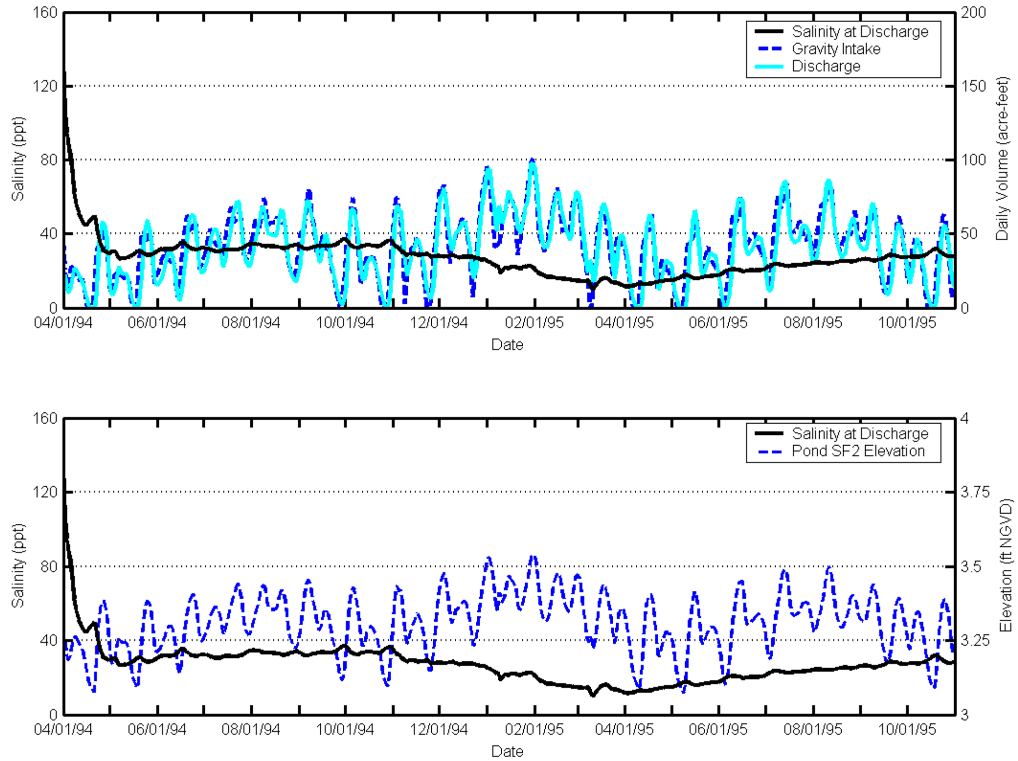
Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

Figure 4-30
Graph of West Bay 3 Operational Levels and Discharge Salinities



Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

Figure 4-31
Graph of West Bay 4 Operational Levels and Discharge Salinities



Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

Figure 4-32

Graph of West Bay SF2 Operational Levels and Discharge Salinities

4.2.13.4 Management Operations

The West Bay ponds will require limited active management. Once the muted tidal and tidal circulation operation has been established the operation would only require active management to adjust the operating water surface elevations. With outlet weirs, this may be necessary for an unusual event or maintenance, or to improve the habitat conditions within the ponds. Without the outlet weirs, the water levels would be controlled by the outlet control gate settings. The gate settings may require adjustment on weekly or monthly periods.

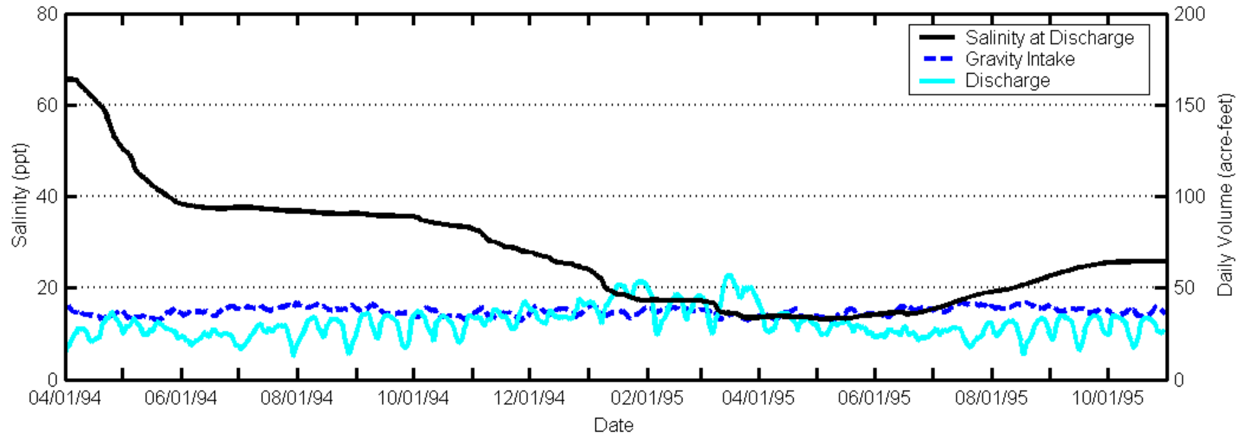
The five separate sub systems in the West Bay complex include intake/outlet structures. Since the inflows and outflows would occur at the same location, there may be limited mixing within the individual ponds. Shallow areas within the ponds may not be well mixed by wind and wave action. For ponds 1, 2, 3, and 4, the Ravenswood pump station and existing connection structures between the ponds may be used to increase mixing by providing circulation to other locations within the individual ponds.

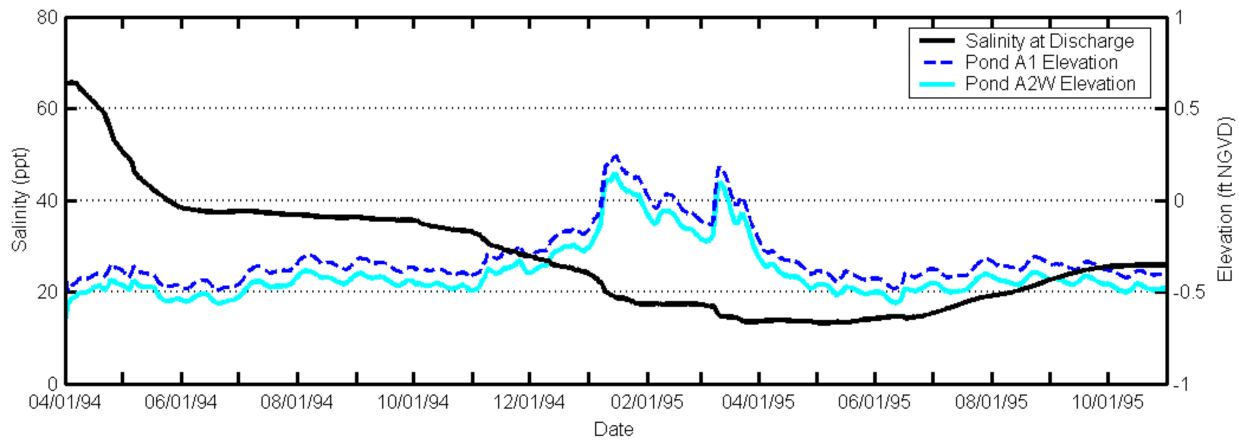
4.3 Proposed Permit Initial Release Scenarios

This section presents the salinity curves for two proposed permit initial release scenarios: Maximum Initial Salinity and Phased Release. The structures of the complexes will remain as presented in Section 4.2.

4.3.1 Maximum Initial Salinity

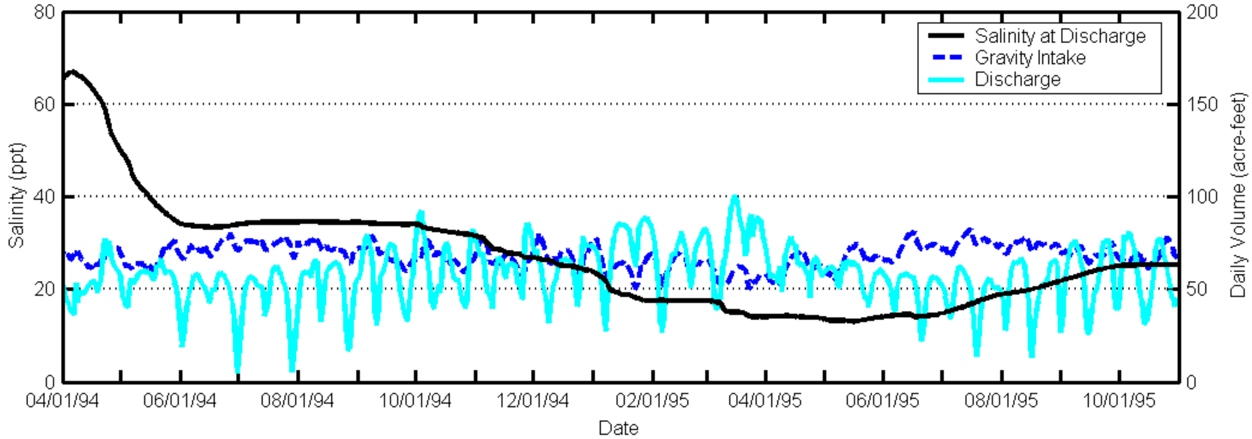
All systems except the island ponds (A19, A20, and A21), the A23 system, and the West Bay pond group to begin discharge in April. Initial pond salinities based on the maximum salinities from Table 4.1.5. The initial release scenario was modeled for 18 months from April through the following October. The initial release level salinity results from the maximum scenario simulations follow.

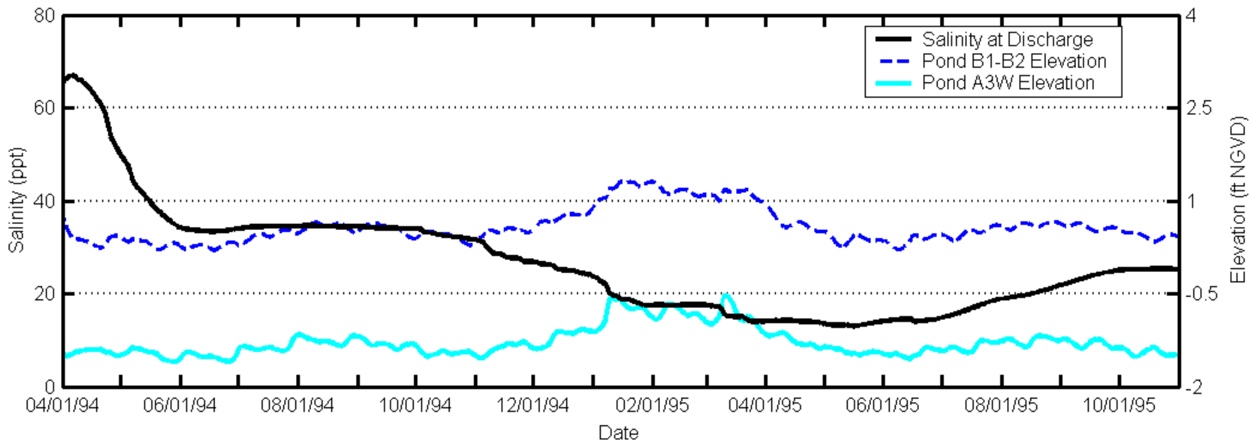




Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

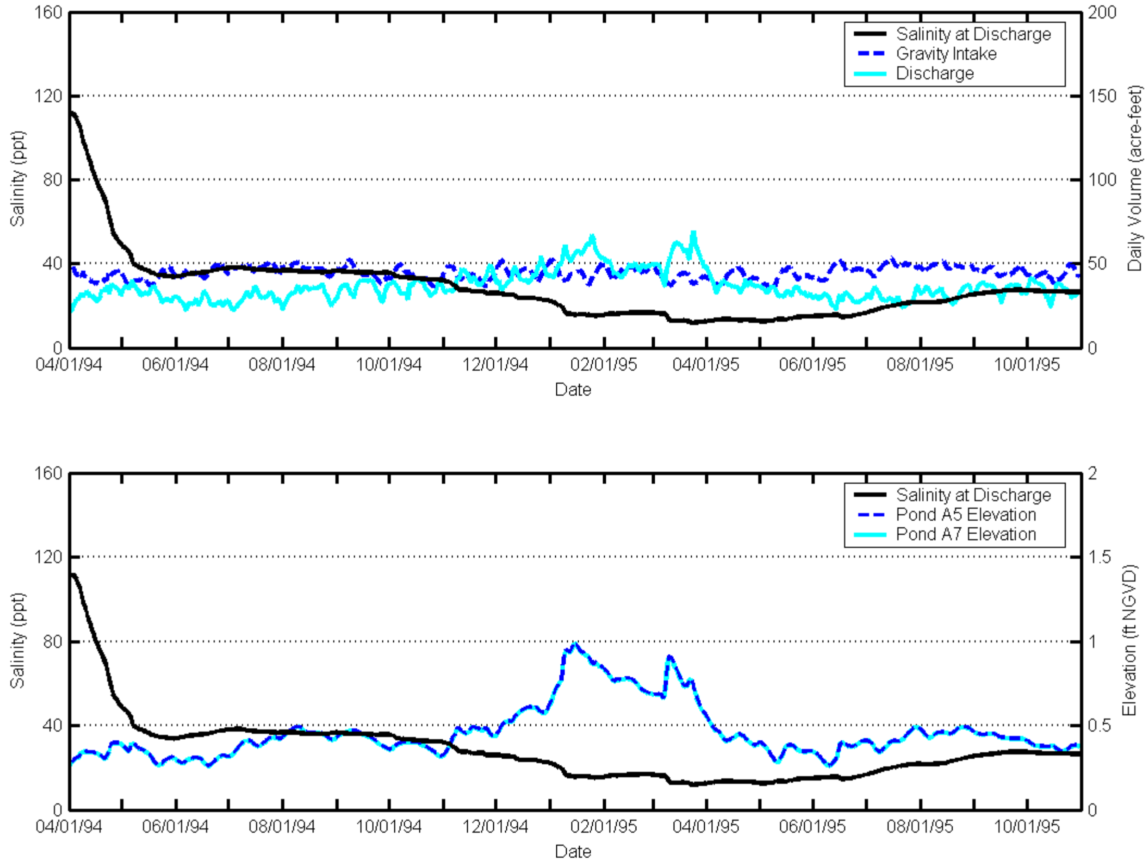
Figure 4-33
Graphs of Alviso A2W Maximum Levels and Discharge Salinities





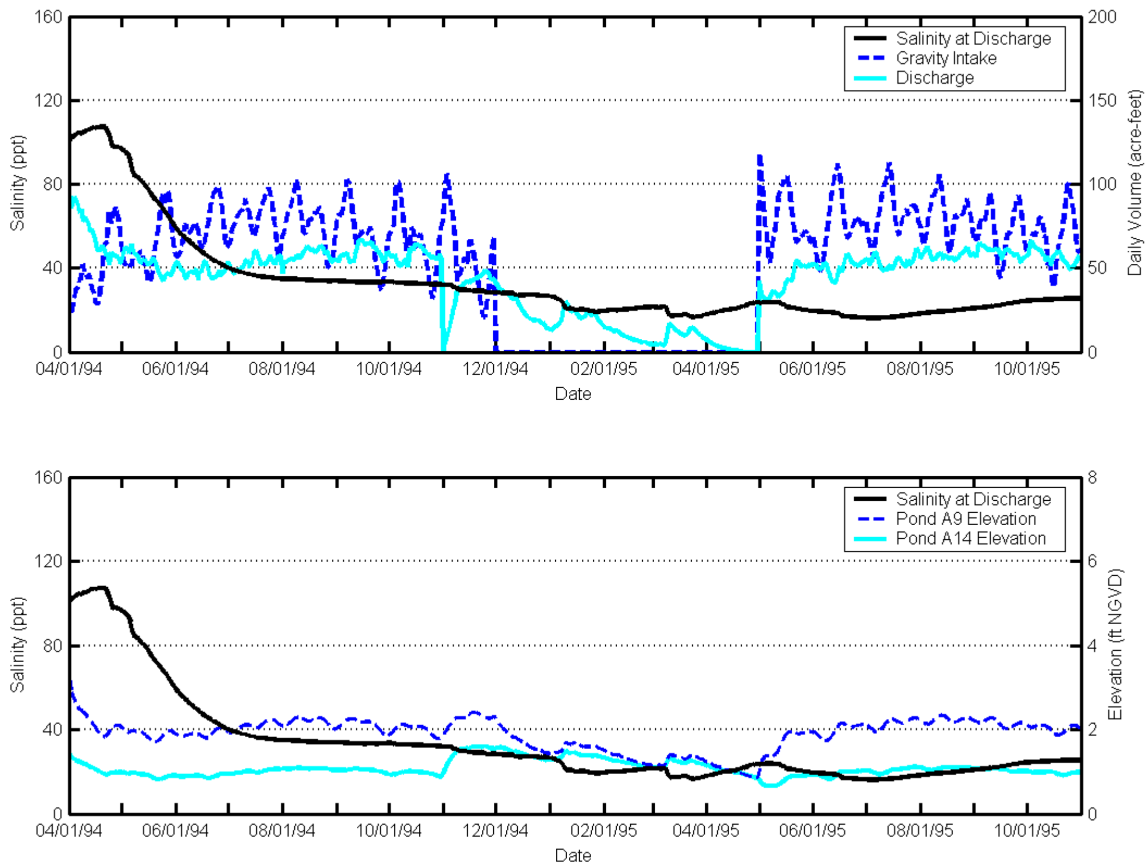
Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

Figure 4-34
Graphs of Alviso A3W Maximum Levels and Discharge Salinities



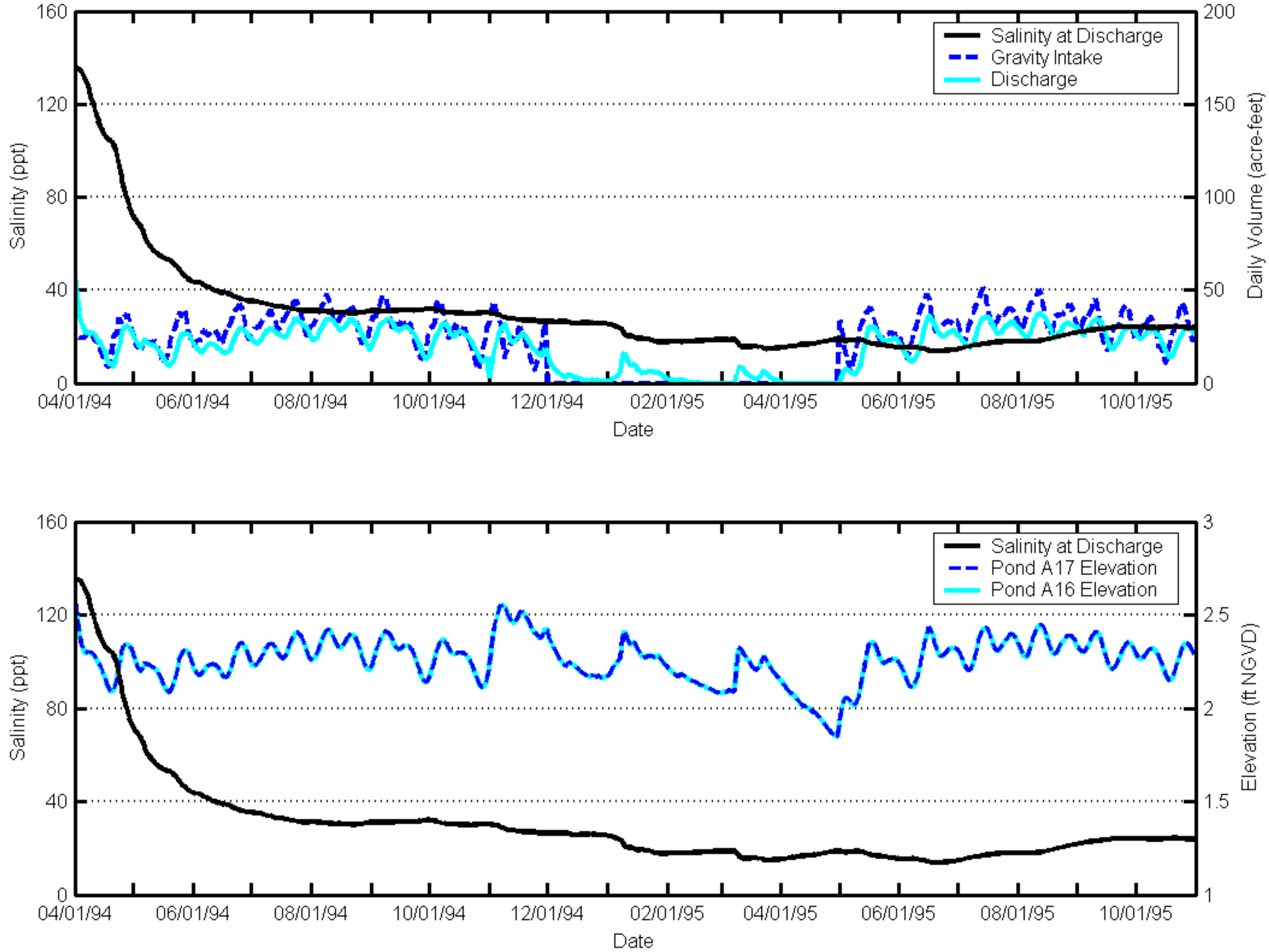
Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

Figure 4-35
Graphs of Alviso A7 Maximum Levels and Discharge Salinities



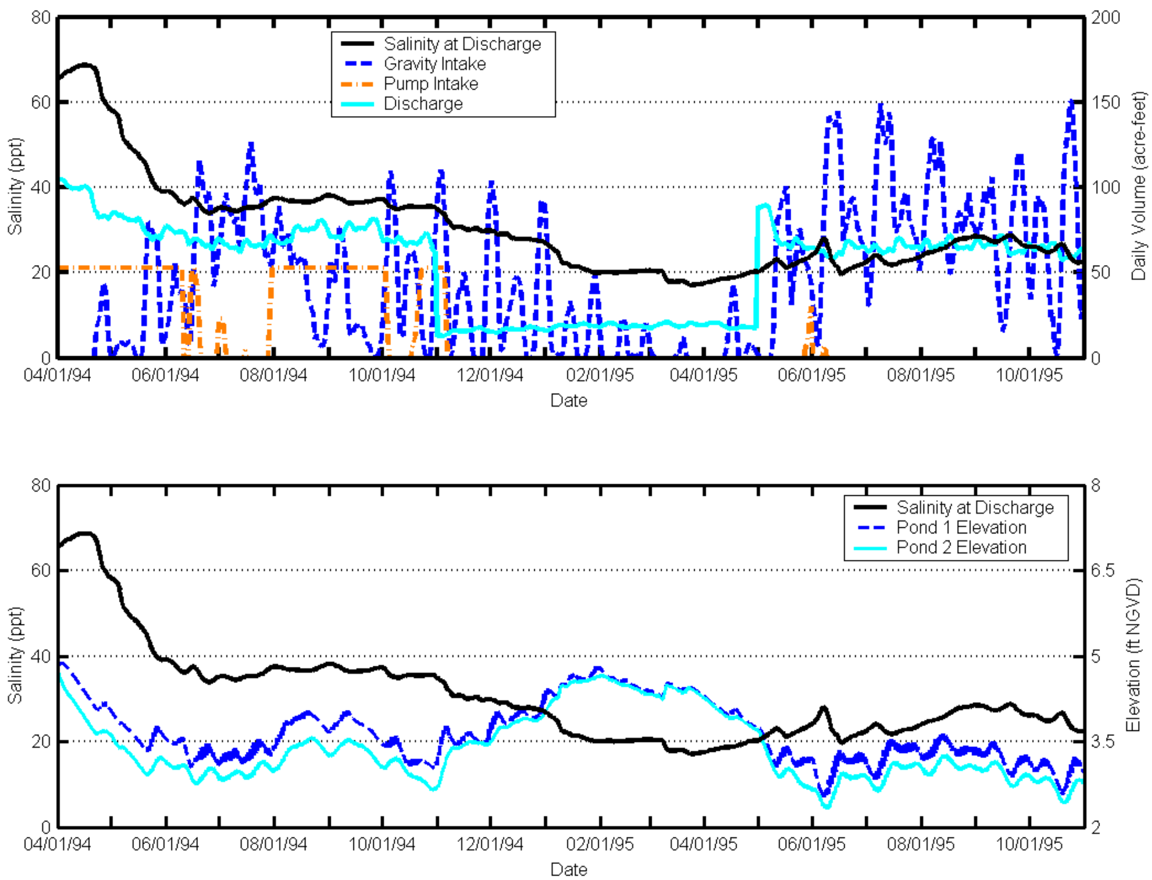
Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

Figure 4-36
Graphs of Alviso A14 Maximum Levels and Discharge Salinities



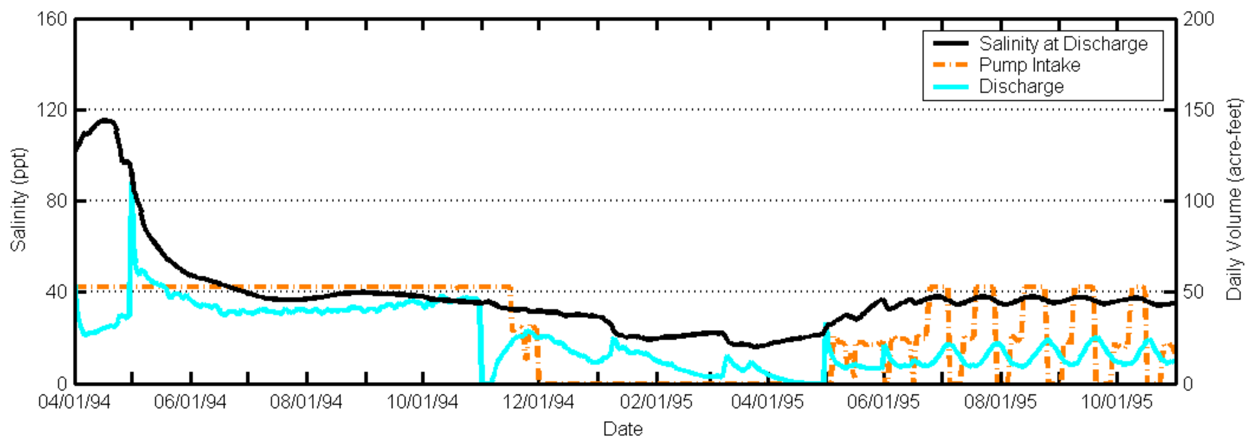
Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

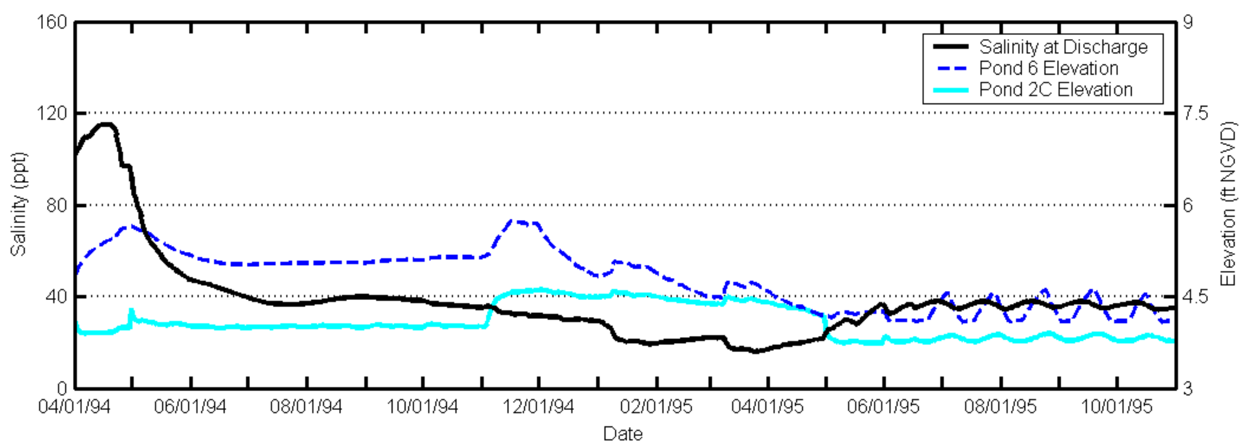
Figure 4-37
Graphs of Alviso A16 Maximum Levels and Discharge Salinities



Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

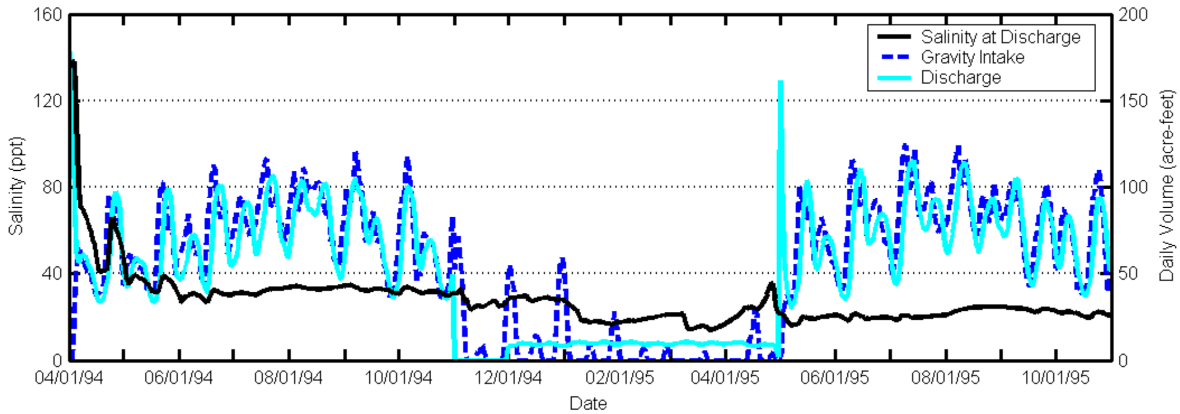
Figure 4-38
Graphs of Baumberg 2 Maximum Levels and Discharge Salinities

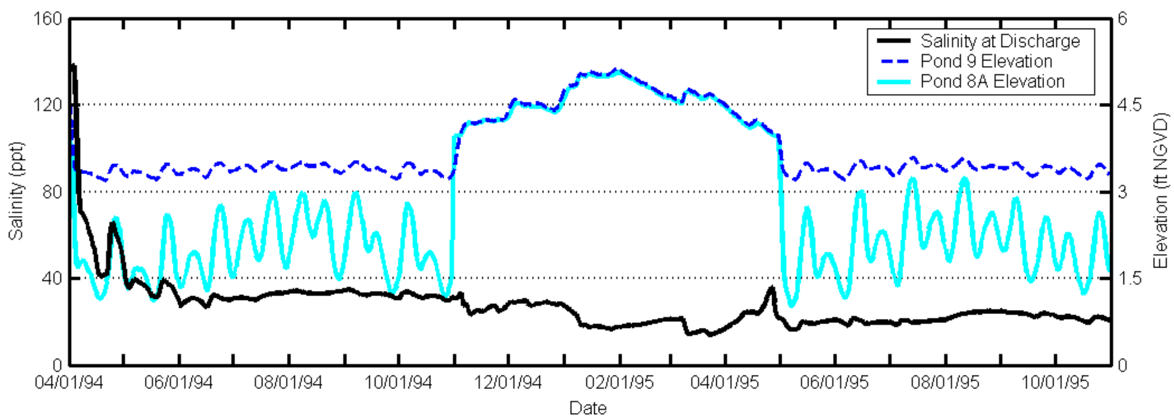




Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

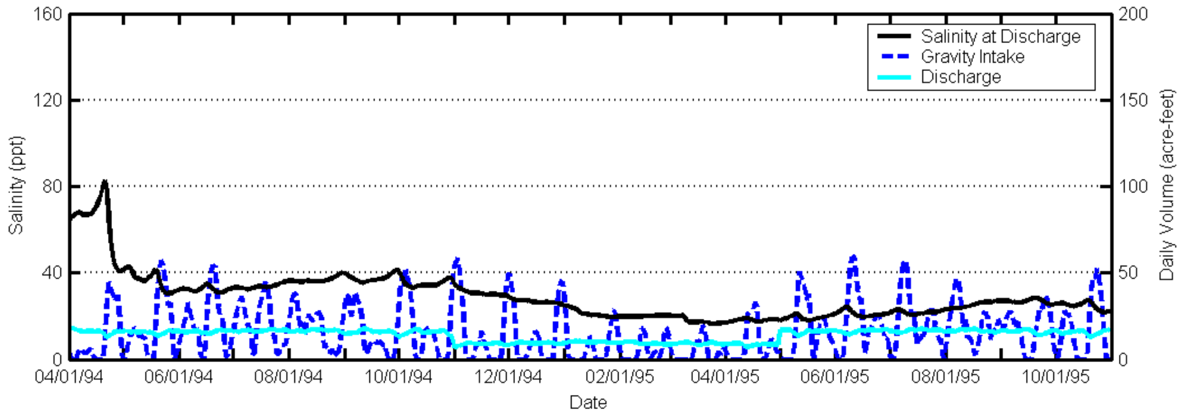
Figure 4-39
Graphs of Baumberg 2C Maximum Levels and Discharge Salinities

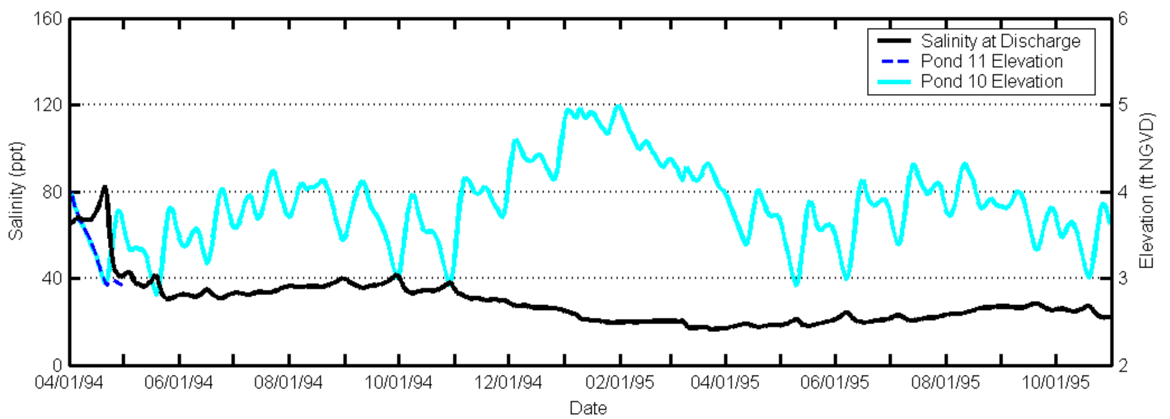




Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

Figure 4-40
Graphs of Baumberg 8A Maximum Levels and Discharge Salinities



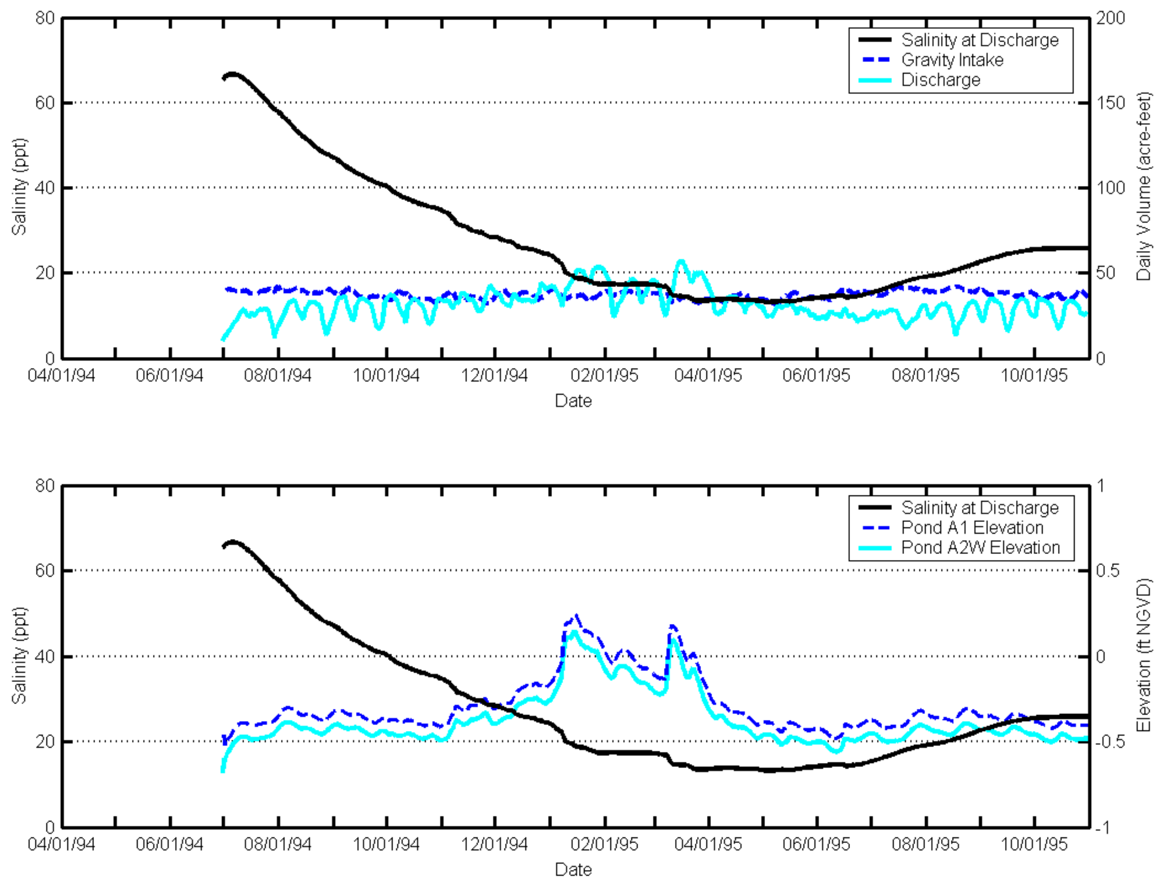


Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

Figure 4-41
Graphs of Baumberg 11 Maximum Levels and Discharge Salinities

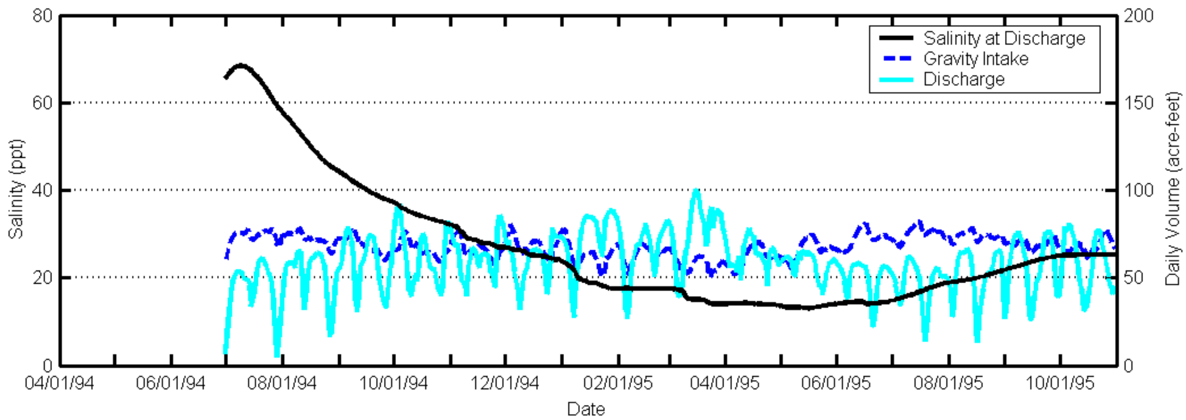
4.3.2 Phased Release

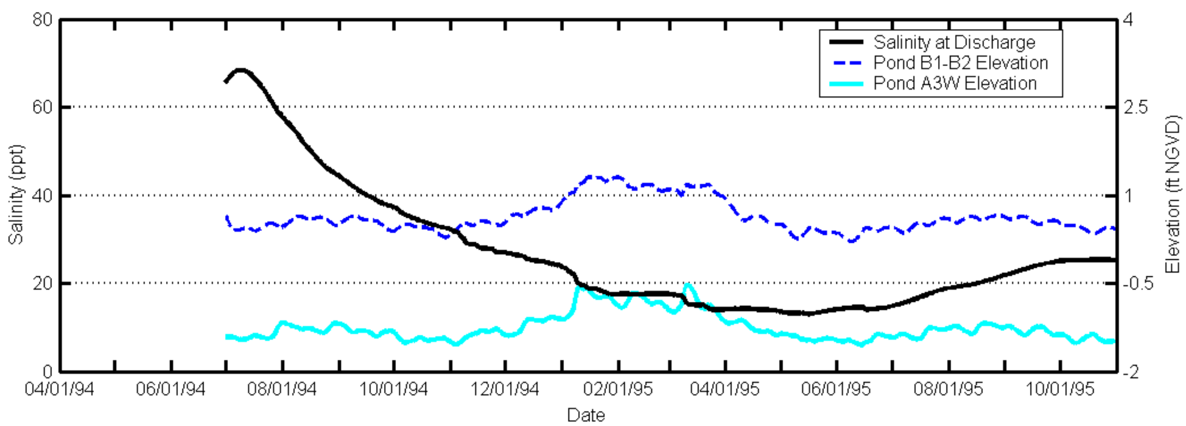
The Phased release scenario is to release selected groups of ponds or individual ponds over time. This approach was chosen to adapt management strategies in subsequent releases. The initial phase will include Alviso Systems A2W, A3W, A7 and Baumberg Systems 2, 8A and 11. The ponds were selected to represent a significant number of systems that could be included in a first phase of the project based on construction and operational constraints. The remainder of the ponds would be released the following year. The phased release was assumed to begin in July, to allow for some construction in the spring after the winter rainy season. Most of the proposed system structures would not be accessible for construction during the winter. The initial pond salinities for this modeling effort were based on the worst case conditions of the maximum salinities from Table 4.1.5. The initial release scenario was modeled for 16 months from July through the following October. After the modeled initial release period, the long term operation conditions would be the same as the operation results shown in Section 4.2. The initial salinity and pond release level results from the simulations follow.



Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

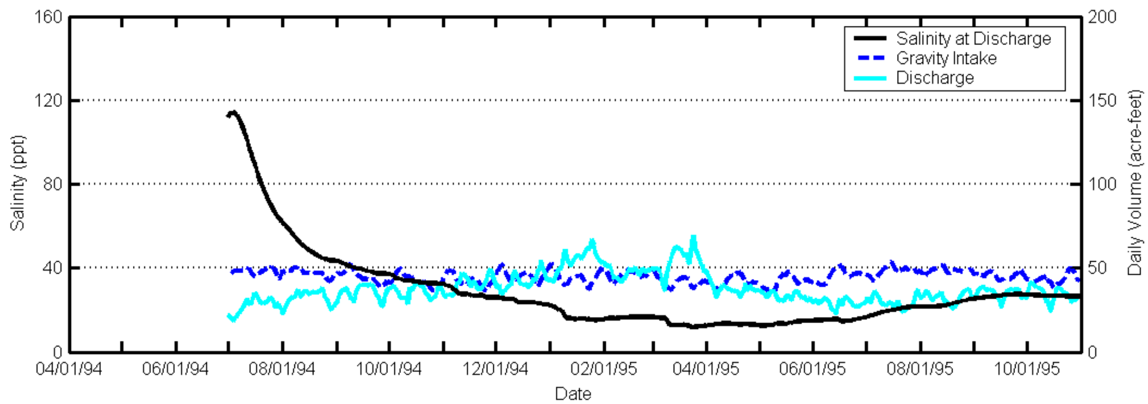
Figure 4-42
Graphs of Alviso A2W Phased Release Levels and Discharge Salinities

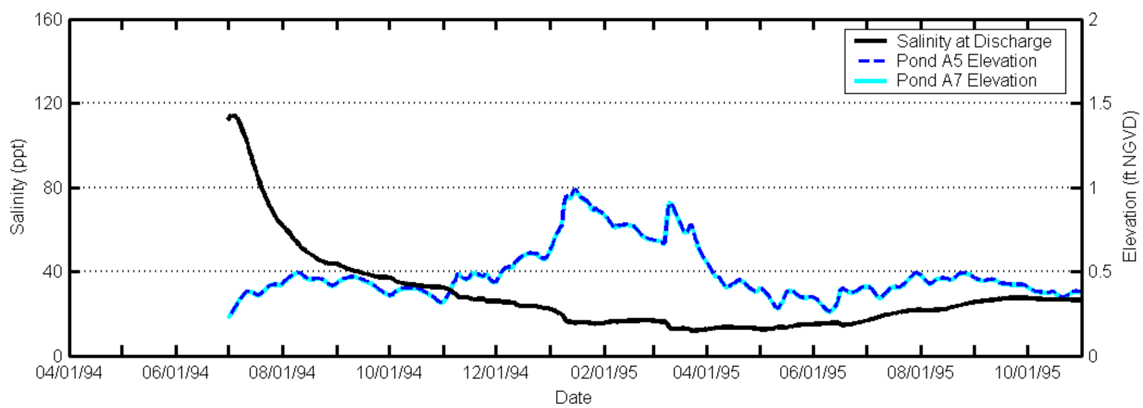




Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

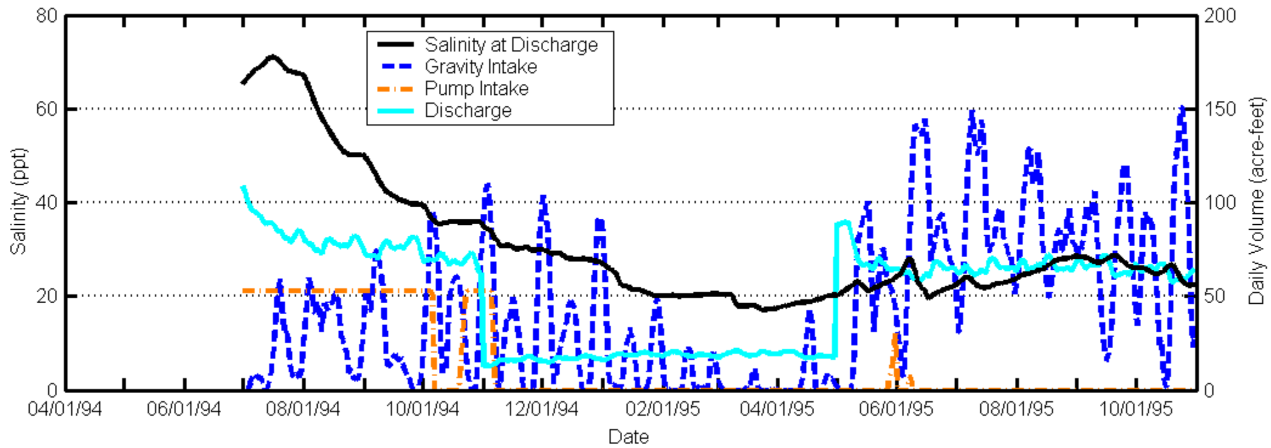
Figure 4-43
Graphs of Alviso A3W Phased Release Levels and Discharge Salinities

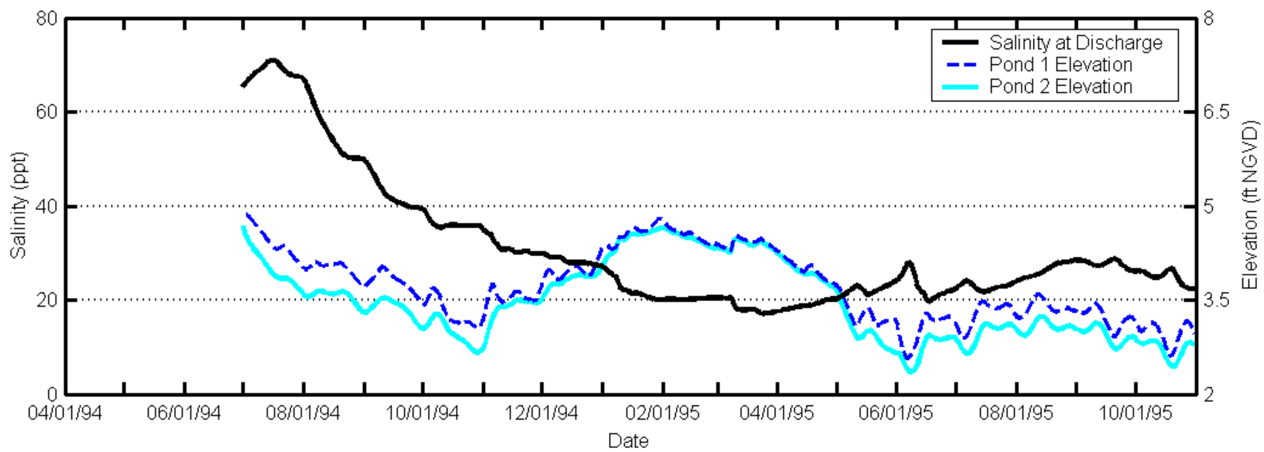




Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

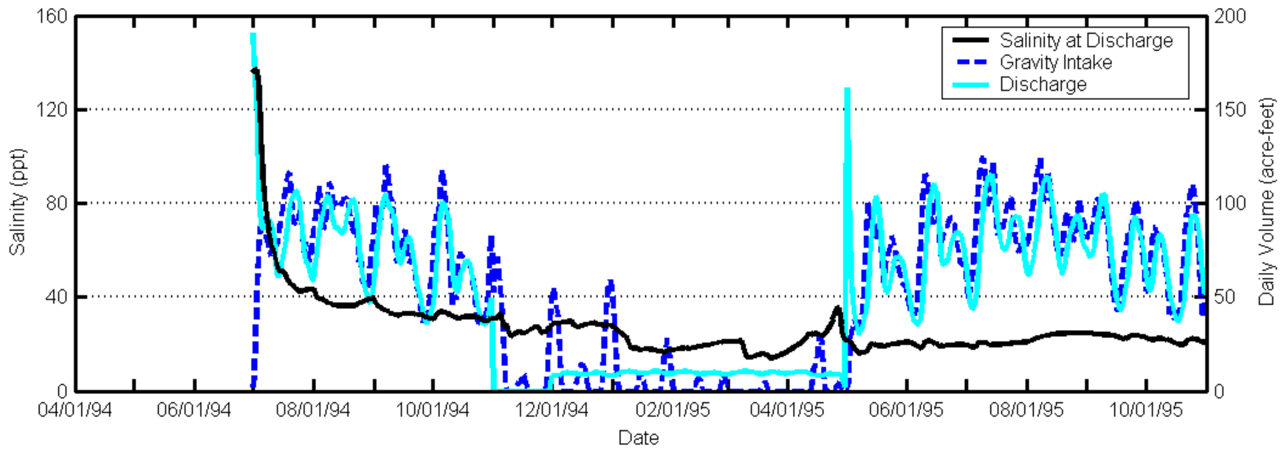
Figure 4-44
Graphs of Alviso A7 Phased Release Levels and Discharge Salinities

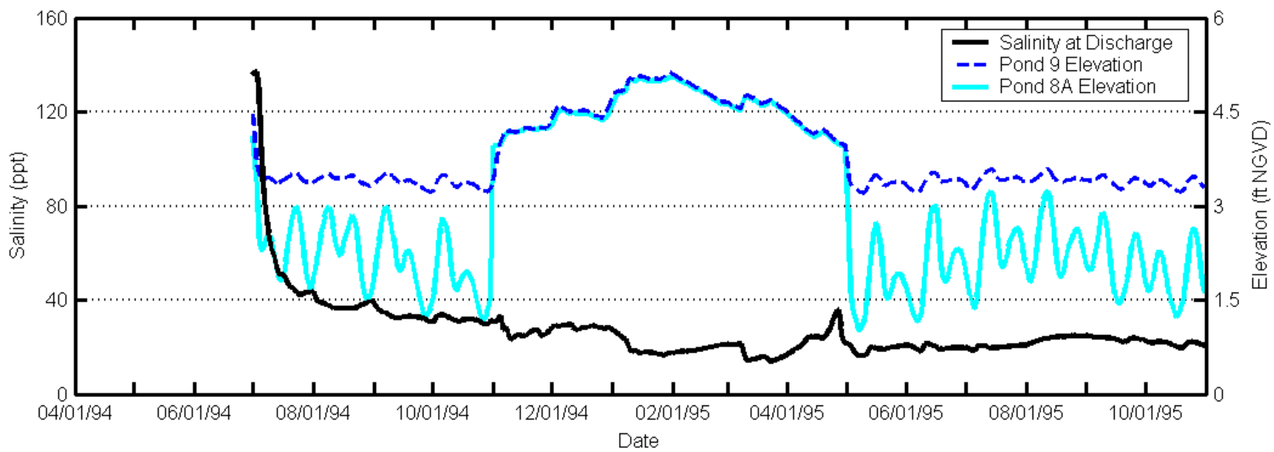




Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

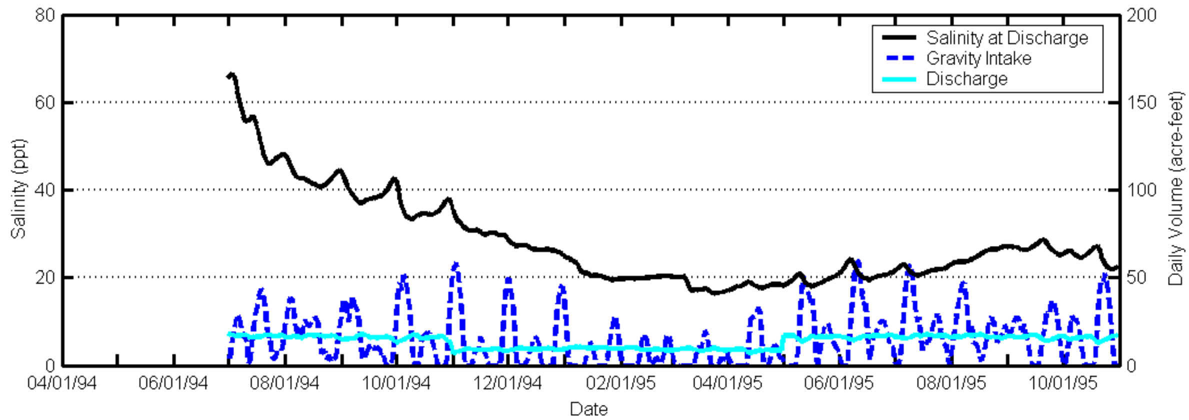
Figure 4-45
Graphs of Baumberg 2 Phased Release Levels and Discharge Salinities

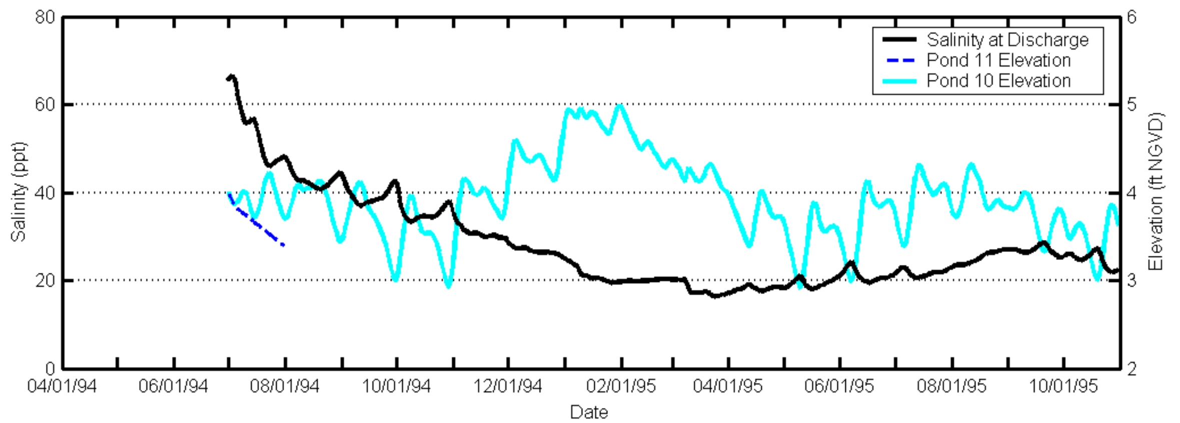




Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

Figure 4-46
Graphs of Baumberg 8A Phased Release Levels and Discharge Salinities





Note: Salinity and pond operation predicted based on 1994-1995 weather and tidal conditions

Figure 4-47
Graphs of Baumberg 11 Phased Release Levels and Discharge Salinities

4.4 Public Access

Under prior management for commercial salt operations, most of the ponds included in the ISP were closed to public access. However, Alviso Ponds A-9 through A-17 and the West Bay Ponds 1 and 2 were previously owned by the U.S. Fish and Wildlife Service as part of the Don Edwards San Francisco Bay National Wildlife Refuge (Refuge) and were open to the public for pedestrian and bicycle access to promote wildlife observation, wildlife photography, interpretation, and environmental education opportunities. These ponds will continue to be open for similar public access activities during the Initial Stewardship period. General public access to other ponds in the Alviso, Baumberg and West Bay complexes will be limited to regularly scheduled docent-led tours during Initial Stewardship. More extensive public access opportunities in these areas will be developed during the long-term South Bay Salt Pond restoration planning process.

For many years prior to the recent acquisition of the ponds by State and Federal agencies, Cargill had provided waterfowl hunting opportunities on many of its Baumberg and Alviso salt ponds through leases to private individuals. In addition, the Refuge's West Bay Ponds 1 and 2 have been open to public waterfowl hunting for many years during the State designated season (generally October through January). During the Initial Stewardship period, the Refuge intends to continue to allow public waterfowl hunting via foot access on West Bay Ponds 1; to open Alviso Ponds A-2E, A-3W, B-1, and B-2 for waterfowl hunting via access by boat, and to open Alvixo Ponds A-5, A-7, and A-8W for waterfowl hunting via access by foot or boat during State-designated seasons. Cargill has previously issued private waterfowl hunting leases on all the aforementioned Alviso Ponds. These opportunities will now be available to the public. More detailed information on the hunting plan for the Refuge ponds, such as access and timing restrictions, will be included as an Appendix to the EIR/EIS.

4.5 Construction Period Resource Protection Measures

The following Best Management Practices will be employed to protect wetland and biological resources:

Construction for implementation of the ISP will be timed to avoid impact to critical resources. Construction activities in snowy plover nesting areas will occur between September 1 and February 1 after and prior to the snowy plover nesting season. Earlier start dates may be allowed if monitoring demonstrates that snowy plover nesting is completed and the young are capable of flight.

For any channel excavation, fabric (silt fence) or heavy gage plastic fences will be erected along the edges of the excavation areas. The exclusion fences will be maintained in working condition through completion of the work. Additionally, no construction work will occur within 700 feet of clapper rail nesting habitat during the nesting season between February 1 and August 31, unless prior monitoring studies indicate no clapper rail nesting activity.

Qualified biological monitors knowledgeable of the restoration and management plan goals and objectives and familiar with salt marsh harvest mouse, clapper rail, and snowy plover biology and habitat requirements will be utilized to oversee construction activities. The monitors' responsibilities will include:

- Remain present on the site during all excavation and other construction work in or adjacent to occupied habitats for the listed species.
- Stake or fence areas to be avoided by construction equipment.
- Retain authority to control or halt construction activity that is not consistent with the approved construction plans and any amendments.

- Notify the Department of Fish and Game, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, and Regional Water Quality Control Board of any unanticipated damage to protected habitat areas, erosion or water quality problems in excess of permit requirements, or dead or injured listed species.

The following specific measures shall be implemented to the maximum extent practicable in order to minimize project impacts. Section 4.5.1 describes measures needed to prevent pollution during construction. Section 4.5.2 describes measures needed to protect wildlife during construction and subsequent operation and maintenance periods.

4.5.1 Pollution Prevention

4.5.1.1 Siltation Controls

Install silt fences, localized silt barriers or other erosion control measures during construction in wetland and aquatic habitats located in creeks and sloughs. No sediment controls will be applied when runoff is directed toward pond interiors unless sensitive wildlife resources are identified.

Maintain siltation controls in properly functioning condition in accordance with the manufacturer's specifications and good engineering practices. Controls will be removed after construction. Should sediment escape the construction site, off-site accumulations of sediment will be removed and placed in a location directed toward pond interiors.

4.5.1.2 Hazardous Materials

All wastes created during construction (e.g. trash, excess construction material, etc.) would be removed from the construction area and disposed of in an approved disposal site. No trash or other solid waste pollutants will be buried within the construction area or discharged into waters of the United States. All applicable State and or local waste disposal regulations will be complied with.

Generation of fugitive dust would be minimized by accepted practices. If precipitation occurs during construction, vehicular traffic along the construction corridor will be minimized to reduce the potential for erosion.

Gasoline, diesel fuels, lubricants and other potential pollutants would be stored in containers that would prevent their accidental release. Any unused lubricants or used engine oil will be removed from the site and disposed of at an approved facility. Additional steps to prevent the accidental discharge of potential pollutants are described in a project-specific spill prevention plan.

Overnight or out-of-use equipment will be parked on impervious mats/tarps to capture leaking oil and lubricants.

Routine maintenance of equipment will be limited to fueling and lubricating equipment. No major cleaning or major equipment repairs would be conducted at the construction site.

Prior to construction an environmental inspector who will verify the limits of authorized construction work areas and identify any additional stabilization needed or special construction management needed to protect sensitive wildlife. During construction if deposition or disturbance impairing water quality or harming wildlife occurs, the construction activity will be ceased and rescheduled or the design of the discharge will be changed to prevent reoccurrence.

4.5.2 Wildlife Protection Measures

4.5.2.1 During Installation of Water Control Structures

Use only those locations which were identified in the plan, since they have minimum coverage of pickleweed or other marsh vegetation outboard of the levee and are generally located away from major salmonid migration routes. Any adjustments at the site during installation should be concurred upon by a qualified biologist.

Identify, maintain and protect existing vegetated aquatic habitats by marking limits of construction for all equipment. Silt fencing will be used to delineate construction area boundary. Construction access, staging and temporary soil stockpile areas will be contained within the identified construction area.

Minimize construction activities near colonial nesting bird colonies during breeding seasons.

Either conduct construction activities between September 1 and February 1 to avoid the California clapper rail breeding season; or, conduct call counts using standardized protocols prior to construction.

4.5.2.2 During Breaching of Levees

Activities may be conducted by dredge or land-based equipment.

For external levees, if pond holds water:

- Remove final segment of levee materials at high tide to allow some internal mixing before waters are discharged to the bay.
- If pond is dry, remove final segment of levee materials at either low or high tide.
- Avoid breaching activities near nesting bird colonies during breeding season.

For external levee breaches near vegetated wetland habitats:

- Either remove levee materials between September 1 and February 1 to avoid the California clapper rail breeding season; or, conduct call counts using standardized protocols prior to construction. Construct breaches during the breeding season only if no rails are found within 700 feet of the structure site.
- Avoid breaching dry ponds during the snowy plover breeding season, breaching will occur only after September 1, or if surveys show no nesting snowy plovers in the ponds.

4.5.2.3 Operation of Water Control Structures

Manage pond levels to allow a two-foot freeboard to prevent over-topping of the levees during storm conditions.

To the extent practicable, manage intake and outflows to achieve an adequate turnover of pond waters throughout the year to reduce excessive buildup of algae and other odor- producing materials. It is recognized that all ponds surrounding the Bay will produce algae.

Provide regular maintenance of trash racks and intake and outflow structures to assure that they are operating properly.

To reduce impacts to juvenile salmonids during migration, seasonally close intake structures at Pond A-9 and A17 (December through April)

Operate flow-through ponds, seasonal ponds and batch ponds, to maintain and enhance waterbird habitats. Monitor waterbird use of the ponds and adapt water management activities to meet their needs, while maintaining discharge limits identified in this ISP.

5.0 South Bay Salt Pond Restoration Monitoring

Monitoring will be conducted to document compliance with the California Regional Water Quality Control Board discharge requirements, wildlife use, and to determine management requirements. Specific monitoring studies will be conducted to assess:

- Water quality and sediment data
- Salinity and water depths in the ponds for management
- Presence of avian botulism
- Water bird distribution, composition, and abundance;

Additional surveys and studies conducted through university research or by private individuals are encouraged. All study protocols, however, will require approval from the Department of Fish and Game and the U.S. Fish and Wildlife Service.

5.1 Water Quality and Sediment Monitoring

Objectives: The objectives of this monitoring program are to:

- Demonstrate compliance with California Regional Water Quality Control Board, San Francisco Bay Region's discharge requirements
- Document the areal and temporal extent of water quality excursions from ambient
- Document the responses of the biota (fish and invertebrates) to releases of brine into the South Bay and tributaries
- Provide in-pond water quality, and sediment data upon which to manage the pond systems to best meet discharge criteria, and prevent conditions that may exacerbate wildlife exposure to contaminants, or increase the spread of avian botulism.

Salinity and water levels currently are recorded on a weekly basis in the ponds. In addition to other water quality monitoring, the initial stewardship plan would include similar weekly monitoring. There are existing staff gages in most ponds. A new gage will be placed in any pond that currently does not have an existing gage.

5.1.1 Sample Functions and Locations

The functions and locations of the water quality and sediment monitoring will be established in the EIR/EIS.

5.2 Salinity and Water Depth for Pond Management

To assure proper salinity and desired water depths, pond depths within the ponds for habitat management and for managing discharges, and salinities will be monitored weekly as access conditions permit. Water levels in ponds with nesting islands will be assessed for either flooding or land bridging of the islands. The condition of levees, pumps, and other infrastructure will be tracked as well.

At the Baumberg Complex, the transition from summer to winter operation will occur in November with summer operations beginning in April. These dates were determined by historic weather patterns. This is typically when the ratio of evaporation to precipitation shifts. These dates will be altered in years where there is a substantial change from normal evaporation and precipitation.

5.3 Wildlife

5.3.1 Waterbird Distribution, Composition, and Abundance

Since waterbirds have come to rely on the existing salt pond system, and since water levels and salinities in the system will be modified by the ISP, waterbirds will be monitored to determine changes in their distribution, composition, and abundance. The U.S. Geological Survey has monitored Alviso Ponds 9 through 16 for several years and is conducting baseline research monitoring for all ponds included in the ISP from April 2003 to April 2004. The surveys are being conducted once monthly at high tides. The data being collected includes species, numbers, type of use (feeding/roosting), and grid location within the pond. The area covered includes the crown of the levee to the center of the pond.

Following implementation of the ISP, monthly surveys would be conducted in each pond system at high tides. Species and number data will be collected by pond and compared to the baseline information. Additionally, each spring, at least one "window" survey will be conducted in all DFG and FWS ponds (including those not part of the ISP). During a "window" survey all ponds are counted at a high tide at essentially the same time to determine the distribution of shorebirds in the South Bay. Data on species, numbers, and locations will be collected.

5.3.1.1 Breeding Surveys

Nesting waterbirds can be impacted by changing water levels near the nest sites on levess and islands, as well as changes on food availability. A number of colonial breeding bird surveys are presently conducted in the South Bay Salt Ponds, mainly by the San Francisco Bay Bird Observatory (SFBBO). Rather than duplicate those efforts, the ISP would use those survey results to identify nest sites in need of protection from water level fluctuation. In addition to the islands within the ponds, interior levees will be checked monthly from March to July for nesting shorebirds (e.g., stilts and avocets) which could be affected by water levels.

5.3.1.2 Avian Botulism

Outbreaks of avian botulism generally occur in fresh to brackish waters in late summer and fall when air and water temperatures are high. In the South Bay, this has occurred in areas near existing South Bay water treatment facilities. The salt ponds in the ISP most likely to be affected are the ponds closest to these existing water treatment facilities. The effluent channels are presently surveyed by SFBBO. The following actions will be taken to reduce the spread of avian botulism.

- If there is evidence of avian botulism in areas surveyed by SFBBO, Refuge Staff will survey the adjacent ponds using shallow draft boats.
- All personnel conducting operational activities on the ponds will be trained to recognize symptoms of avian botulism and would make special observation efforts during late August, September, and October when outbreaks generally occur.
- If dead birds are found, they will be retrieved and incinerated in an approved facility. Sick birds will be brought to an approved avian restoration facility.

List of Acronyms

ABAG	Association of Bay Area Governments
af	acre-feet
AFCC	Alameda Flood Control Channel
BCDC	San Francisco Bay Conservation and Development Commission
bgs	Below ground surface
BMP	Best management practices
BOD	Biological Oxygen Demand
Caltrans	California Department of Transportation
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
cm	centimeter
cms	cubic meters per second
CNPS	California Native Plant Society
Corps	US Army Corps of Engineers
DEM	Digital Elevation Model
DFG	California Department of Fish and Game
EA	Environment Assessment
EAP	Emergency Action Plan
EIR	environmental impact report
EIS	environmental impact statement
EOP	Emergency Operations Plan
EPA	US Environmental Protection Agency
ER-L	Effects Range - Low
ER-M	Effects Range - Median
FEMA	Federal Emergency Management Agency
FR	Federal Register
gpm	Gallons per Minute
GPS	Global Positioning System
GRR	General Re-Evaluation and Environmental Report
HEC-RAS	Hydrologic Engineering Center-River Analysis System
HRT	Hydraulic Residence Time
ISP	Initial Stewardship Plan
km	kilometer
LCA	Local Cooperative Agreement
LS!	Life Science! Inc.
MDL	Mean Detection Limit
mgd	Megagallons per day
MHHW	mean higher high water
MHW	mean high water
MLLW	mean lower low water
MMP	migration and monitoring plan
NEPA	National Environmental Policy Act
NGVD	National Geodetic Vertical Datum
NHC	Northwest Hydraulic Consultants
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Agency
NOP	Notice of Preparation
PG&E	Pacific Gas and Electric Company
ppm	Parts per million
ppt	Parts per thousand
RMS	Root mean squared (average dynamic)
ROW	right-of-way
RWQCB	San Francisco Bay Regional Water Quality Control Board

SCVWD	Santa Clara Valley Water District
SEMS	Standardized Emergency Management System
SFBBO	San Francisco Bay Bird Observatory
SMP	Stream Maintenance Program
SR	State Route
SSFB	South San Francisco Bay
SWPPP	stormwater pollution prevention plan
TBD	To be Determined
TBS	To be Supplied
TRIM	Tide, Residual, Intertidal, and Mudflat
UPRR	Union Pacific Railroad
US 101	US Highway 101
USDA	US Department of Agriculture
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey
WQO	Water Quality Objection

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ASSESSMENT OF IMPACT TO AQUATIC LIFE ASSOCIATED WITH CIRCULATION OF SALINE POND WATER DURING THE INITIAL STEWARDSHIP PERIOD

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1. INTRODUCTION

During the Initial Stewardship Period (ISP), saline water will be discharged from several salt ponds in the Alviso, Baumberg, and West Bay Units into the southern reaches of San Francisco Bay and its tributaries. These discharges will have the potential to adversely impact aquatic life because they will alter, at least locally, the water quality conditions in the receiving waters. In this document, an assessment is made to determine whether such impacts are likely to occur and, if so, to estimate their magnitude and duration. The assessment consists of several components. First, the aquatic community that inhabits the receiving waters in the vicinity of the discharge is identified. Second, those water quality issues associated with the discharge that have the potential to adversely impact the aquatic community are enumerated. Third, each of these issues is evaluated to determine whether the aquatic community might be adversely impacted and, if so, to quantify the extent of the anticipated impact. Fourth, a literature review was performed to provide an estimate of how long it might take for the estuarine community in the slough and bay segments to recover, if adverse impacts were to occur.

Discharge Points Considered in the Assessment - It is anticipated that ten pond discharges (i.e., Alviso A2W, A3W, A7, A14, and A16 and Baumberg 2, 2C, 8A, 11, and 6A) will commence during the first year of the ISP and they are considered in this assessment. The locations of these ponds are illustrated in Figure 1-1. The remainder of the ponds (i.e., all of the West Bay ponds and the Alviso Island Ponds A19, A20, and A21) will not commence discharging until later years and, therefore, were not addressed at this time.

Discharge Conditions Considered in the Assessment - Throughout this document, each of the various impacts is evaluated over the entire ISP, which includes both a short-term Initial Release Period and a long-term Continuous Circulation Period. The Initial Release Period is when the highest salinity waters (estimated to be up to 135 ppt) will be pushed out of the ponds. After the Initial Release Period, which is expected to last approximately two months, bay water will be continuously circulated through the ponds so that pond salinities are maintained at levels suitable for future restoration. During the Continuous Circulation Period, the discharge salinities may be as high as 44 ppt, but generally will be considerably lower. The Continuous Circulation Period will continue until the ISP ends and, therefore, is likely to last for several years.

At this time, it is not certain when the Initial Release Period will begin and what the salinity of the ponds will be at that time. The timing of the Initial Release Period is dependent upon the completion of both the permit process and the construction of necessary infrastructure. The salinity of the ponds at the beginning of the Initial Release period will be influenced primarily by climatic conditions and the consequent balance between precipitation and evaporation. In order to cover the range of conditions under which the Initial Release Period might begin, the following three scenarios are considered in evaluating potential impacts:

- The first scenario assumes that the discharge from 9 ponds (i.e., Alviso A2W, A3W, A7, A14, and A16 and Baumberg 2, 2C, 8a, and 11) commences on April 1 and the salinities of the salt ponds are equal to the values observed in 2002. This set of conditions is designated Initial Release (April 2002 Salinity Scenario).

- The second scenario assumes that the same 9 ponds commence discharge on April 1 and the salinities of the salt ponds are equal to the maximum values that have been observed over the past five years or could be expected during a very dry year. This set of conditions is designated Initial Release (Proposed Maximum Salinity Scenario).

- The third scenario assumes that the commencement of the initial release is phased, beginning on July 1 and involving six ponds (Alviso A2W, A3W, and A7 and Baumberg 2, 8A, and 11) which are at their proposed maximum salinities. This set of conditions is designated the Phased Initial Release (Proposed Maximum Salinity Scenario).

2. AQUATIC COMMUNITIES IN RECEIVING WATERS

During the ISP, there will be several points of discharge, with discharged water entering directly into San Francisco Bay at several locations (i.e., in the vicinities of the Alviso, Baumberg, and West Bay units) and into several tributaries to the bay (i.e., Alviso Slough, Coyote Creek, Guadalupe Slough, Old Alameda Creek, and Alameda Flood Control Channel). Each of these receiving waterbodies is inhabited by a community of estuarine fish and invertebrate species, which could be exposed to any of the associated changes in water quality. The aquatic community that inhabits these locations has not been well characterized. However, available data provide some insight as to the likely community composition.

Fish Community in Sloughs – The composition of the fish communities in the five tributaries into which pond water will be circulated (i.e., Coyote Creek, Alviso Slough, Guadalupe Slough, Alameda Flood Control Channel, and Old Alameda Creek) can be estimated based on surveys performed in these and adjacent trbituaries. In a five-year study (1982-86) performed for the South Bay Dischargers Association (SBDA) (Kinnetics 1987), fish were collected and identified from two locations in Coyote Creek (SJ2 and SJ4) and one location in Guadalupe Slough (SJ6). The results of this study indicate that these tributaries are inhabited by a number of estuarine fish species, including staghorn sculpin (*Leptocottus armatus*), northern anchovy (*Engraulis mordax*), starry flounder (*Platichthys stellatus*), shiner perch (*Cymatogaster aggregate*), yellowfin goby (*Acanthogobius flavimanus*), threadfin shad (*Dorosma petenense*), and longfin smelt (*Spirinchus thaleichthys*).

A more recent study performed for the City of Palo Alto (Cressey 1997) confirms that the fish species observed in the sloughs in the 1982-1986 are probably still present. In two tributaries to South Bay (i.e., San Francisquito Creek and the channel from the Palo Alto wastewater treatment plant to the bay), several fish species were collected including northern anchovy and topsmelt (*Atherinops affinis*), yellowfin goby, staghorn sculpin, and threespine stickleback.

Fish Community in Bay Proper – The 1982-86 SBDA study (Kinnetics 1987) also provides data on the likely composition of the fish community in the waters of southern San Francisco Bay proper in the vicinity of the proposed pond discharges. Based on this study, it appears that the fish species in the bay proper will be quite similar to those found in the sloughs and will include northern anchovy, staghorn sculpin, shiner perch, longfin smelt, white croaker (*Genyonemus lineatus*), and striped bass (*Morone saxatilis*). The results of this study are based on samples collected from two locations in South San Francisco Bay – one location is designated SB4 and is just north of the Dumbarton Bridge and the other location is designated SB5 and is midway between the Dumbarton Bridge and the mouth of Coyote Creek.

Benthic Community in Sloughs – The composition of the benthic invertebrate communities inhabiting the five tributaries into which pond water will be circulated is not well characterized. No benthic data could be found for any of the five tributaries in question. However, the 1997 City of Palo Alto study (Cressey 1997) does provide data that are probably relevant to the five tributaries of concern. In the Cressey study, benthic communities in San Francisquito Creek and the discharge channel from the Palo Alto Wastewater Treatment Plant were sampled and the collected specimens identified. These two tributaries will not be receiving circulated pond water, but since they are geographically close to the tributaries in question and have similar morphologies, it is likely that they will also have similar benthic communities. The results of this study indicate that benthic communities in the tributaries of concern are likely to be fairly simple, with the most abundant taxa being four species of annelids (*Neanthes succinea*, *Eteoni lighti*, *Tubificidae spp*, and *Heteromastus filiformis*), three species of arthropods (*Nippoleucon hinumensis*, *Corophium alienense*, and *Grandidierella japonica*), and two species of molluscs (*Macoma balthica* and *Potamocurbula ameurensis*). Interestingly, all of these species, except for *P. ameurensis,* were found at all stations in both tributaries, with salinities ranging from 1 to 27 ppt.

Benthic Community in Bay Proper – The composition of the benthic invertebrate community inhabiting the mudflats of South San Francisco Bay has been described by Nichols and Thompson (1985a & 1985b). Based on data from 1974-83, it appears that the communities in the vicinity of the Alviso Unit and the Baumberg Unit are probably very similar, with three species being "the overwhelming numerical dominants" – these are *Gemma gemma* (a mollusc), *Ampelisca abdita* (an arthropod), and *Streblospio benedictii* (an annelid). In addition, according to Nichols and Thompson (1985b), "although much less abundant, the mollusks *Macoma balthica*, *Mya arenaria*, and *Illyanassa obsoleta* often represent the bulk of benthic invertebrate biomass".

A more recent dataset was collected in 1994-96 as part of the Benthic Pilot Study of the San Francisco Estuary Regional Monitoring Program (RMP 1997). Based on these data, for estuarine muddy sediments, the most common and abundant species are *Potamocorbula amurensis*, *Ampelisca abdita, Nippoleucon hinumensis*, *Corophium heteroceratum*, *Corophium alienense*, *Grandiderella japonica*, *Balanus improvisus*, *Tubificidae sp.*, *Neanthes succinea*, and *Streblospio benedicti* . These data indicate that the species composition in the bay sediments in the vicinity of the Alviso and Baumberg Units has remained fairly consistent over time, with the exception of the marked increase in the abundance of a recent invading species *Potamocorbula amurensis*.

3. OVERVIEW OF POTENTIAL ISSUES OF CONCERN

As part of the permit application process, estimates were made as to the expected chemical and physical nature of the water that will be discharged from the salt ponds during the ISP. A review of these estimates indicates that salinity, certain metals, and biological oxygen demand (BOD) may be present in discharged pond water at concentrations that exceed background levels in the receiving waters. In addition, discussions with the Resource Agencies indicated a special concern that circulated pond water might interfere with the migration of salmonids and reduce rearing habitat for juvenile bay shrimp. In the following sections of this evaluation, each of these issues is considered to determine the potential for impacts to aquatic life in the receiving waters.

In brief, the following major conclusions can be drawn from the evaluations presented in the subsequent sections of this document:

1. Even if the ponds discharge at their proposed maximum salinities, the resulting salinity in the receiving waters, during both the Initial Release and Continuous Circulation Periods, is unlikely to exceed the tolerance levels of most of the resident fish and invertebrate species. Under existing conditions, the salinity in the receiving waters varies considerably on a daily basis (due to tidal cycles and rainfall conditions). In general, the discharge of pond water will tend to narrow the daily salinity range by primarily increasing the daily minimum values and having little effect on the daily maximums.

2. There are likely to be some relatively small exceedences of the applicable nickel and mercury water quality objectives in the receiving waters as a result of the pond discharges. However, these exceedences are predicted to be temporary (lasting for a matter of weeks) and of small spatial extent (1 or 2 kms of slough length). Available data indicate that, during certain times of the year, water quality objectives for nickel and mercury are currently being exceeded in the receiving waters. During these periods, the discharge of pond water is not predicted to significantly affect compliance.

3. It is unlikely that the discharge of pond water will cause anoxic conditions in the receiving waters. The oxygen demand associated with the circulated pond water is expected to be primarily due to the presence of algae and, consequently, even a short diurnal light period should be sufficient to prevent decreases in dissolved oxygen concentrations to harmful levels.

4. The initial release from the ponds is scheduled to begin in early April in order to coincide with the time of the year when the densities of bay shrimp are at their lowest in the receiving waters and, therefore, any potential impacts will be minimized. Assuming an early April commencement and pond salinities at 2002 values, the discharge of pond water is not predicted to have an adverse impact on the amount of preferred shrimp habitat in the receiving waters. If initial pond salinities are at their proposed maximum levels, temporary local decreases in preferred shrimp habitat are predicted for a few months following the commencement of initial discharge. Under all discharge scenarios, the major change will be a shift of the most preferred salinities to locations further upstream in the sloughs in question.

5. The major concern for downstream migrating juvenile salmonids, associated with the circulation of pond water, is the potential for entrainment of these small fish into the ponds through intake structures. This potential has been greatly diminished operationally by closing the intake structures during the peak downstream migration periods.

6. The major concern for upstream migrating salmonids, associated with the circulation of pond water, is the potential of the discharge to interfere with the signal that these adults follow to their spawning grounds. Based on 3-dimensional mathematical modeling, it is predicted that the pond discharges will not adversely affect the ability of the adult salmonids to find their spawning grounds. "Natal-stream water" gradients, the most likely signal, will remain intact in each of the migration corridors during upstream migration periods. Salinity gradients (which are less likely signals) will remain intact for the major portion of the upstream migration periods. However, breaks in salinity gradients occur naturally and do not appear to affect the upstream migrating adult salmonids' ability to find their spawning grounds.

7. The initial release of pond water is scheduled to begin in either early-April or early-July in order to provide maximum protection to the salmonids. Highest salinity waters would be discharged prior to the fall and winter upstream migration periods of adults and after the "winter-early spring" downstream migration period of juveniles.

4. POTENTIAL FOR SALINITY IMPACTS

During the ISP, the salinity of the discharges from the Alviso Unit, Baumberg Unit, and West Bay Unit ponds will generally be greater than the salinity of the receiving waters. The greatest differences in salinity between discharge and receiving water will occur during the Initial Release Period, when the highest salinity waters (estimated to be up to 135 ppt) will be pushed out of the ponds. There will be variation between discharge points, but, in general, the discharge of the higher salinity waters will last for between 1 and 2 months, with the salinity of the discharge decreasing over time. After this Initial Release Period, bay water will be continuously circulated through the ponds so that pond salinities are maintained at levels suitable for future restoration. During the Continuous Circulation Period, the discharge salinities may be as high as 44 ppt. However, under most scenarios, the actual discharge salinities during this Continuous Circulation Period will be considerably less than 44 ppt. Estimates of the range of salinities of each of the discharges, during the Initial Release and Continuous Circulation Periods, are summarized in Table 4-1. It should be noted that, for the Initial Release Period, three sets of salinity ranges are presented. These are described in Section 1 of this report.

There is a concern that, during the ISP, the relatively high salinity of the discharges might cause the salinity of receiving waterbodies in the South Bay (i.e., segments of the bay proper and adjoining sloughs) to exceed the tolerances of resident aquatic species and, consequently, have an adverse impact on the resident aquatic communities. To address this concern, a comprehensive evaluation was performed which is described in detail in a separate document prepared by S.R. Hansen & Associates entitled, “Evaluation of the Potential for Impacts to Aquatic Life due to the Elevated Salinity of Pond Water Circulated during the Initial Stewardship Period”. This document is provided as an appendix to this report. The following is a summary of the approach and results.

Approach - The concern about the potential for elevated salinity of the circulated pond water to adversely impact aquatic life inhabiting segments of the receiving waters was evaluated using a multi-step approach. First, the range of salinities for each of the discharges was predicted for both the Initial Release and Continuous Circulation Periods. Second, predictions were made as to how the discharges would alter the salinity in segments of the receiving waters (i.e., both in sloughs and in the bay proper) during both Initial Release and Continuous Circulation periods. Third, based on available data, estimates were made as to the composition of the aquatic communities in the various waterbodies into which pond water would be circulated. Fourth, based on a review of the scientific literature, the sensitivity of resident aquatic organisms to changes in salinity was estimated. Fifth, the predicted salinity changes were compared with the estimated salinity tolerances of the resident species to predict what, if any, salinity-related impacts resident species might suffer from the proposed discharges.

General Overview of Results - The results of this evaluation indicate that during the Initial Release Period, salinities in segments of S.F. Bay and its tributaries are predicted to be elevated, but significant impacts to aquatic life would be unlikely. The highest elevations are predicted for the sloughs and creeks into which pond water will be directly circulated (i.e., Alviso Slough, Gaudalupe Slough, Coyote Creek, and Alameda Flood Control Channel). However, even under worst-case discharge conditions (i.e., all ponds simultaneously commence discharge at maximum proposed salinities), the resulting salinities should still be within the tolerance range of most resident species. Under more realistic discharge conditions (i.e., only a subset of the ponds simultaneously commence discharge at lower salinities), salinity elevations in these tributaries would be considerably lower and potential risk to aquatic life would be minimal. In South S.F. Bay proper (south of the San Mateo Bridge), salinity elevations (depth-averaged and daily-averaged) under worse-case discharge conditions are predicted to be only in the 1 to 2 ppt range, except for very localized areas near actual discharge points and slough mouths, where elevations may reach 4 ppt. Such small increases in salinity, which will last less than two months, are not expected to adversely impact resident aquatic species.

During the Continuous Circulation Period, salinity elevations in all segments of S.F. Bay and its tributaries are predicted to be sufficiently low so as not to present a risk to resident aquatic life. In S.F. Bay, salinity elevations (depth-averaged and daily-averaged) are predicted to be quite localized and not to exceed 1 ppt at any time of the year. In the tributaries, salinity increases are predicted to vary seasonally, with very low values during the winter and somewhat higher values during the late summer and fall (i.e., highest pond salinities and lowest tributary flow). Even during the worst-case times of the year, salinities in the tributaries during the Continuous Circulation Period are not expected to pose a risk to resident aquatic life.

Results and Conclusions by Site - Throughout the ISP, each of the various segments of the bay and its tributaries will experience a different exposure to saline pond water. Therefore, it is most informative to address each of these segments separately in evaluating the potential for salinity-related impacts. It should be noted that the salinities reported in this discussion are daily and depth-averaged values.

South Bay Proper - During the Initial Release Period, under worst-case conditions, the increase in salinity is predicted to be less than 3 ppt, except in very localized areas near discharge points and at the mouths of sloughs where increases may be as high as 4 ppt. The salinity increases are predicted to be less under more realistic discharge conditions. Based on the available literature, these small increases in salinity are unlikely to adversely impact the estuarine species which are resident in the impacted segments of South San Francisco Bay. The resident organisms in the South Bay normally experience variations of several ppt on a daily basis and up to 10 ppt on a seasonal basis and many of the resident species are likely to have salinity tolerances greatly in excess of 32 ppt. The ability of estuarine species to tolerate salinities significantly higher than full-strength seawater (32 ppt) is described in Hopkins (1973) and summarized in Table 4-2.

During the Continuous Circulation Period elevated salinities in the South Bay proper are expected to be virtually non-existent. It is predicted that any increases will be 1 ppt or less and occur in very localized areas near discharge points and at the mouths of sloughs. Consequently, impacts to aquatic life in South Bay proper, resulting from elevated salinity, are not expected during the long-term Continuous Circulation Period.

Alameda Flood Control Channel –During the Initial Release Period, under worst-case conditions, the maximum increase in salinity is predicted to be 14 ppt in the vicinity of the Pond 2C discharge. Salinity increases will be lower in other segments of the channel and nowhere in the channel will depth-averaged and daily-averaged salinities exceed approximately 37 ppt. At the end of the Initial Release Period, a maximum salinity increase of 6 ppt will occur in the vicinity of the Pond 2C discharge point and lower salinity increases will occur in other segments of the channel. The maximum salinity during the Initial Release Period under more realistic conditions, similar to those observed in 2002, is predicted to be approximately 30 ppt. The salinity increases are predicted to be less under these more realistic discharge conditions, with local maximum increases being in the 2-4 ppt range. Based on the available literature, these increases in salinity are unlikely to adversely impact the estuarine species which are resident in the impacted segments of the Alameda Flood Control Channel. The resident organisms in the AFCC normally experience variations of 15-20 ppt on a daily basis and up to 30 ppt on a seasonal basis and many of the resident species are likely to have salinity tolerances greatly in excess of 32 ppt.

During the Continuous Circulation, elevated salinities in the AFCC are expected to be quite low. It is predicted that any increases will be in the range of 1-4 ppt and occur in channel segments near the Pond 2C discharge point. Consequently, impacts to aquatic life in the AFCC, resulting from elevated salinity, are not expected during the long-term Continuous Circulation Period.

Coyote Creek – During the Initial Release Period, under worst-case conditions, the maximum increase in salinity is predicted to be 14 ppt in the vicinity of the Pond A14 discharge. Salinity increases will be lower in other segments of the creek and nowhere in the creek will depth-averaged and daily-averaged salinities exceed approximately 32 ppt. At the end of the Initial Release Period, a maximum salinity increase of 6 ppt will occur in the vicinity of the Pond A14 discharge point and lower salinity increases will occur in other segments of the creek. The maximum salinity during the Initial Release Period under more realistic conditions, similar to those observed in 2002, is predicted to be approximately 26 ppt. The salinity increases are predicted to be less under these more realistic discharge conditions, with local maximum increases being in the 1-5 ppt range. Based on the available literature, these increases in salinity are unlikely to adversely impact the estuarine species which are resident in the impacted segments of Coyote Creek. The resident organisms in Coyote Creek normally experience variations of 15-20 ppt on a daily basis and up to 30 ppt on a seasonal basis and many of the resident species are likely to have salinity tolerances greatly in excess of 32 ppt.

During the Continuous Circulation Period, elevated salinities in Coyote Creek are expected to be quite low. It is predicted that any increases will be 3 ppt or less and will occur in creek segments near the Pond A14 discharge point. Consequently, impacts to aquatic life in Coyote Creek, resulting from elevated salinity, are not expected during the long-term Continuous Circulation Period.

Alviso Slough – During the Initial Release Period, under worst-case conditions, the maximum increase in salinity is predicted to be 20 ppt in the vicinity of the Pond A7 discharge. Salinity increases will be lower in other segments of the slough and nowhere in the slough will depth-averaged and daily-averaged salinities exceed approximately 37 ppt. At the end of the Initial Release Period, a maximum salinity increase of 8 ppt will occur in the vicinity of the Pond A7 discharge point and lower salinity increases will occur in other segments of the slough. The maximum salinity during the Initial Release Period under more realistic conditions, similar to those observed in 2002, is predicted to be approximately 26 ppt. The salinity increases are predicted to be less under these more realistic discharge conditions, with local maximum increases being in the 2-18 ppt range. Based on the available literature, these increases in salinity are unlikely to adversely impact the estuarine species which are resident in the impacted segments of Alviso Slough. The resident organisms in Alviso Slough normally experience variations of 15-20 ppt on a daily basis and up to 30 ppt on a seasonal basis and many of the resident species are likely to have salinity tolerances greatly in excess of 32 ppt.

During the Continuous Circulation Period, elevated salinities in Alviso Slough are expected to be moderate. It is predicted that any increases will be 8 ppt or less and will occur in slough segments near the Pond A7 discharge point. Consequently, impacts to aquatic life in Alviso Slough, resulting from elevated salinity, are not expected during the long-term Continuous Circulation Period.

Guadalupe Slough - During the Initial Release Period, under worst-case conditions, the maximum increase in salinity is predicted to be 18 ppt in the vicinity of the Pond A3W discharge. Salinity increases will be lower in other segments of the slough and nowhere in the slough will depth-averaged and daily-averaged salinities exceed approximately 37 ppt. At the end of the Initial Release Period, a maximum salinity increase of 14-16 ppt will occur in the vicinity of the Pond A3W discharge point and lower salinity increases will occur in other segments of the slough. The maximum salinity during the Initial Release Period under more realistic conditions, similar to those observed in 2002, is predicted to be approximately 30 ppt. The salinity increases are predicted to be less under these more realistic discharge conditions, with local maximum increases being approximately 6 ppt. Based on the available literature, these increases in salinity are unlikely to adversely impact the estuarine species which are resident in the impacted segments of Guadalupe Slough. The resident organisms in Guadalupe Slough normally experience variations of 5-15 ppt on a daily basis and up to 30 ppt on a seasonal basis and many of the resident species are likely to have salinity tolerances greatly in excess of 32 ppt.

During the Continuous Circulation Period, elevated salinities in Guadalupe Slough are expected to be moderate. It is predicted that any increases will be 8 ppt or less and will occur in slough segments near the Pond A3W discharge point. Consequently, impacts to aquatic life in Guadalupe Slough, resulting from elevated salinity, are not expected during the long-term Continuous Circulation Period.

5. POTENTIAL FOR TOXIC CHEMICAL IMPACTS

The pond water which will be discharged to the bay and its tributaries during the ISP is essentially bay water which has been concentrated via solar evaporation and, therefore, any contaminants that occur in bay water have the potential to occur in the pond discharge. Other possible sources of chemical contaminants in the pond water discharge include desorption from sediments and atmospheric deposition. The concentrations of contaminants originating from bay water may be either increased (due to concentration, desorption, and deposition) or decreased (due to sorption to sediments, uptake by biota, volatilization, and other processes) prior to and during the ISP.

If toxic chemical contaminants are present in circulated pond water, the potential for impact to aquatic life can be estimated by comparing the measured concentrations against established water quality objectives for the receiving waters in question. For discharges from the Alviso Unit, the operative water quality objectives, except for copper and nickel, are established by the USEPA and published in the Federal Register as the California Toxics Rule (40CFR 131.38), which apply to all waters of the San Francisco Bay Estuary south of the Dumbarton Bridge. The operative objectives for copper and nickel in this region of the bay have been established by the San Francisco Regional Water Quality Control Board as site-specific objectives. For discharges from the Baumberg and the West Bay units, the operative water quality objectives are specified in the San Francisco Bay Water Quality Control Plan (SFRWQCB 1995) and apply to all waters of the S.F. Bay Estuary north of the Dumbarton Bridge.

The concern about the presence of toxic chemicals and their possible impact on aquatic organisms in segments of the receiving waters (i.e., segments of the bay and adjoining sloughs) was evaluated in a multi-step fashion. First, samples of pond water, considered representative of ISP conditions, were analyzed to determine which, if any, toxic chemicals might be present in pond discharges during the ISP. Second, these concentrations were compared against their operative water quality objectives to determine if there was a potential for harm to aquatic life. Third, for each chemical which was found to be present in concentrations that exceed their objectives, an evaluation was made to estimate the significance of that exceedence in the receiving waters.

ORGANIC COMPOUNDS

To address the concern about potential impacts associated with organic chemicals in the discharge from ponds during the ISP, water samples were collected in August 2002 from the Alviso Unit, Baumberg Unit, and West Bay Unit ponds. The sample locations were selected in order to obtain the range of types of water that would be expected to be discharged from the salt ponds during the Initial Release and Continuous Circulation Periods. These samples were analyzed for semi-volatile organics as well as dioxins and furans. The results of these analyses are provided in detail in a report by HydroScience Engineers, Inc. entitled “Water and Sediment Quality Sample Report: Cargill Salt Ponds – South Bay”. This report is provided in full as an appendix to this document. In brief, the results of chemical analysis of pond water samples, which are considered representative of future discharges, indicate that organic compounds will not be problematic because they are rarely detected and, if detected, occur at very low concentrations that are below known adverse effect levels. For four of five samples, none of the 67 semi-volatile organic compounds included in the analysis were detected. In the fifth sample, 66 of the 67 compounds were not detected and one compound was found in an unquantifiable trace level. Similarly, for three samples analyzed, dioxins and furans were either undetected or present in concentrations below the method calibration limit.

HEAVY METALS

To address the concern about potential impacts associated with heavy metals in the discharge from ponds during the ISP, a comprehensive evaluation was performed which is described in detail in a separate document prepared by S.R. Hansen & Associates entitled, "Evaluation of the Potential for Impacts to Aquatic Life due to the Presence of Heavy Metals in the Saline Pond Water Circulated during the Initial Stewardship Period". This document is provided as an appendix to this report. The following is a summary of the approach and results.

Approach - The concern about the presence of heavy metals and their possible impact on aquatic organisms in segments of the receiving waters was evaluated in a multi-step fashion. First, applicable water quality objectives for heavy metals were identified for the water bodies into which pond water would be circulated. Second, representative samples of pond water were sampled from the Alviso and Baumberg Units and analyzed to determine the concentrations of heavy metals present in pond water and estimate how these concentrations vary with salinity. Third, based on the predicted salinities of the proposed discharges, these measured metal concentrations were used to estimate the range of metal concentrations that would be present in each proposed discharge during both the initial release and the continuous circulation portions of the ISP. Fourth, for each discharge, the predicted concentration range of each heavy metal was compared against its operative water quality objective to determine if there was a potential for harm to aquatic life. Fifth, for each metal which was predicted to occur in a discharge in concentrations that exceed its objective, an evaluation was made to estimate the significance of that exceedence in the receiving waters.

General Overview of Results – Ten water samples were collected from Alviso and Baumberg Unit ponds in October 2002 and analyzed for dissolved and total concentrations of ten heavy metals. The sample locations were selected to encompass the full range of salinities that will potentially occur in discharges during the ISP. The results of these analyses (as summarized in Table 5-2) were used to estimate metal concentrations in each of the ISP discharges and these estimates were then compared with applicable water quality objectives (as summarized in Table 5-1). Based on this evaluation, it was concluded that 8 of the 10 heavy metals studied (i.e., arsenic, cadmium, chromium, copper, lead, selenium, silver, and zinc) are not expected to exceed applicable objectives at any time, in any of the discharges, during the ISP (i.e., during either Initial Release or Continuous Circulation Periods). On the other hand, this evaluation indicates that there is a potential for both nickel and mercury to be present in the circulated pond waters in concentrations greater than their applicable water quality objectives (see Tables 5-3 and 5-4, respectively). However, these exceedences, if they occur, will be primarily limited to the Initial Release Period (i.e., approximately the first two months of circulation) and will result in only minor elevations in concentrations in limited segments of the receiving water bodies. In addition, in those segments where nickel and mercury concentrations are predicted to increase slightly, there is little potential for harm to aquatic life associated with these increases.

Specific Results Related to Nickel and Mercury – Pond waters discharged during the ISP might exceed applicable nickel and mercury water quality objectives under the following circumstances:

- Dissolved nickel concentrations in discharges from Alviso Unit ponds during the Initial Release Period

- Total nickel concentrations in discharges from the Baumberg and Westside Unit ponds during both Initial Release and Continuous Circulation Periods

- Total mercury concentrations in discharges from Baumberg and Westside Unit ponds during the Initial Release Period.

To determine the significance of these potential exceedences, evaluations were performed to estimate how these discharges would alter concentrations in the receiving waters and how these alterations would impact aquatic life. The results of these evaluations are summarized below.

Dissolved Nickel Discharged from Ponds in the Alviso Unit –The initial comparisons indicated that dissolved nickel concentrations in several of the discharges from the Alviso Unit might exceed the applicable water quality objective for waterbodies south of the Dumbarton Bridge of 11.9 ug/l dissolved nickel. These exceedences are predicted to occur only when ponds are discharging at their proposed maximum salinities and would be limited to the Initial Release Period. The discharges that might exceed water quality objectives (from ponds A7, A14, and A16) have the potential to impact waters in Alviso Slough, Coyote Creek, and portions of South Bay. An in-depth evaluation indicated that after initial mixing, there would be no predicted exceedences of the nickel objective in either Alviso Slough, Coyote Creek, or South S.F. Bay and, consequently, no expected impact to aquatic life in any of these receiving waters.

Total Mercury Discharged from Ponds in the Baumberg Unit –The initial comparisons indicated that total mercury concentrations in all of the discharges from the Baumberg Unit might exceed the applicable water quality objective for waterbodies north of the Dumbarton Bridge of 25 ng/l total mercury. These exceedences were predicted to occur only when ponds are discharging at their proposed maximum salinities and would be limited to the Initial Release Period. Under these conditions, these discharges have the potential to impact waters in the Alameda Flood Control Channel (AFCC), Old Alameda Creek, and portions of South Bay.

In the AFCC, discharge from salt ponds is predicted to have minimal impact on compliance with the mercury water quality objective. When the waters in the AFCC contain average concentrations of total mercury, the discharge from Ponds 2 and 2C, would at worst raise the ambient concentrations in the AFCC by approximately 10% and would result in equaling the objective in 3 to 4 kilometers of the channel. This condition would last for less than 8 weeks; disappearing at the end of the Initial Release Period. When the waters in the AFCC contain maximum concentrations of total mercury, the discharge from Ponds 2 and 2C, would have essentially no effect. Under existing conditions, the mercury objective would be exceeded throughout the creek by between 7 and 10 ng/l and the input from the ponds would increase these concentrations by less than 1 ng/l. Any increases due to the pond discharges would last for less than 8 weeks; disappearing at the end of the Initial Release Period.

In S.F. Bay north of the Dumbarton Bridge, it is predicted that, after initial mixing, salt pond discharges would have no impact on compliance with the mercury water quality objective during the Initial Release Period. When the waters in the South Bay contain average concentrations of total mercury, the discharges from the Baumberg ponds would increase total mercury in ambient bay water by less 1 ng/l and would not cause an exceedence of the mercury objective. When the waters of South Bay contain maximum concentrations of total mercury, the discharge from the Baumberg ponds would have essentially no effect. Under existing conditions, the mercury objective would be exceeded throughout the South Bay by approximately 11 ng/l and the input from the ponds would actually result in a decrease in ambient concentrations (i.e., the concentration of mercury is predicted to be lower in the discharge than in the ambient waters).

Total Nickel Discharged from Ponds in the Baumberg Unit –The initial comparisons indicated that total nickel concentrations in all of the discharges from the Baumberg Unit might exceed the applicable water quality objective for waterbodies north of the Dumbarton Bridge of 7.1 ug/l total nickel. These exceedences have the potential to occur during all phases of the ISP and over a wide range of discharge salinities. During both the Initial Release and Continuous Circulation Periods, these discharges have the potential to impact waters in the Alameda Flood Control Channel (AFCC), Old Alameda Creek, and portions of South Bay.

In the AFCC, it is predicted that, after initial mixing, salt pond discharges would have limited impacts on compliance with the nickel water quality objective during both the Initial Release and Continuous Circulation Periods. During the Initial Release Period, compliance with the nickel objective in the AFCC would depend primarily on the salinity of the discharging ponds. If the ponds discharge at 2002 salinity values, there is no predicted affect on compliance. However, if the ponds discharge at proposed maximum salinities, there is a predicted increase in the area of the AFCC which will be out of compliance (approximately 1 km), but this increase will last less than 8 weeks. During the Continuous Circulation Period, compliance with the nickel objective in the AFCC would depend primarily upon the ambient concentrations of nickel in the AFCC. If the ambient waters contain average concentrations of nickel, it is predicted that, after initial mixing, pond discharges will increase the concentration of total nickel by 1ug/l or less throughout the AFCC and will cause slight exceedences of the nickel water quality objective in 3-5 km of the channel. If the ambient waters contain maximum concentrations of nickel, it is predicted that, after initial mixing, pond discharges will increase the concentration of total nickel by 1ug/l or less throughout the AFCC, but will have no effect on compliance with the nickel objective. Between 4 and 5 km of the AFCC will be out of compliance with the objective regardless of whether the salt ponds are discharging or not.

In S.F. Bay north of the Dumbarton Bridge, it is predicted that, after initial mixing, salt pond discharges would have no effect on compliance with the nickel water quality objective during either the Initial Release or Continuous Circulation Periods. When the waters in the bay contain average concentrations of total nickel, the discharges from the salt ponds would increase total nickel in ambient bay water by 0.5 ug/l or less and would not cause an exceedence of the nickel objective. When the waters of South Bay contain maximum concentrations of total nickel, the discharge from the salt ponds would have essentially no effect on compliance with the nickel objective. Under existing conditions, the maximum ambient nickel concentrations exceed the nickel water quality objective throughout the South Bay by 1 to 3 ug/l and the input from the ponds would not cause measurable changes in these concentrations and, consequently, will not affect compliance.

6. POTENTIAL FOR DISSOLVED OXYGEN SAGS

Reductions in dissolved oxygen (D.O.) have been identified as a concern in potential locations where circulated pond waters would enter receiving water bodies during the ISP. This concern arises from the possibility that circulated pond water may have high biological oxygen demand which could result in depressed D.O. in sloughs, creeks, and portions of the Bay proper. If these D.O. depressions were large enough, they could result in anoxic conditions that would adversely impact aquatic life.

This concern about the potential for DO sags was addressed in a two step process. First, surrogate samples of the discharges were analyzed for DO and 5-day biological oxygen demand (BOD_5). These standard conventional analyses provide a coarse estimate of whether the discharges have a potential to cause a DO sag. Second, comprehensive experiments were performed to ascertain whether this potential for a DO sag would actually occur under site-specific conditions.

CONVENTIONAL CHEMICAL ANALYSIS OF DISCHARGE

Several pond water samples, which are considered representative of the range of types of water that will be discharged from the salt ponds during the ISP, were analyzed for DO and BOD_5 and the results are summarized in Table 6-1. The results of the DO analyses indicate that dissolved oxygen in the discharge is likely to be near saturation. However, lower concentrations of DO may occur, apparently due to high densities of algae in these waters and the associated diurnal cycles of respiration and photosynthesis.

More important than the dissolved oxygen at the point of discharge is the impact that the discharge will have on dissolved oxygen levels after mixing with the receiving waters. The results of BOD_5 analyses, which were performed to gain some insight into this potential, indicate that in 5 days, under worst-case conditions, the amount of oxygen consumed ranged from 4.1 to 115 mg/l. There was no correlation between salinity and BOD ($r^2 = 0.0006$). It should be noted that these 5-day BOD tests are only coarse indicators of the potential of a discharge stream to cause reductions in dissolved oxygen in receiving water bodies. They are worst-case evaluations which tend to over-estimate the level of DO consumption that would occur under realistic conditions at the point of discharge. Conditions are set in these tests to maximize DO consumption, including (1) addition of large concentrations of bacteria, which maximizes bacterial activity and respiration, (2) addition of nutrients, which also increases bacterial growth and respiration, and (3) performance of the tests in the dark, which maximizes algal respiration and eliminates algal photosynthesis.

SITE-SPECIFIC STUDIES TO ADDRESS DO ISSUE

To more accurately address the potential of circulated pond water to reduce DO in the receiving waters (i.e., sloughs and near-shore segments of the bay), comprehensive studies were performed in Fall 2001 and Spring 2002. These studies were designed to empirically evaluate how, under realistic site-specific conditions, the planned discharge of saline pond water would affect the DO in selected receiving water segments. The design and results of these studies are described in detail in a report by S.R. Hansen & Associates entitled "Evaluation of the Potential for Reductions in Dissolved Oxygen Associated with Circulation of Saline Pond Water during the Initial Stewardship Period". This document is provided as an appendix to this report. The following is a summary of the approach and results.

Approach - An evaluation was performed to determine to what extent D.O. would be altered in selected sloughs, creeks, and bay segments as a result of saline pond water circulation during the ISP and how these alterations would affect aquatic life. This evaluation consisted of the performance of 60-day BOD tests on mixtures of saline pond water and receiving water that would be expected near each of the points of discharge during two critical periods of the ISP - early spring (of the first year) and late summer/early fall. The early spring of the first year was evaluated because it is when the initial release will occur and, consequently, when the concentration of pond water will be the highest in sloughs, creeks, and bay segments. The "late summer-early fall" period was evaluated because oxygen demand is routinely the highest during that time of the year due to natural processes (i.e., high temperatures, increased organic material). The 60-day BOD tests were performed under realistic ambient conditions to generate more realistic results. Neither bacteria nor nutrients were added to the mixtures (i.e., only contained the natural flora of bacteria and algae and the ambient concentrations of nutrients) and normal diurnal light cycles were provided (to allow algae to photosynthesize as well as to respire).

For each of the two study periods, the evaluation was accomplished by a mixture of modeling and empirical efforts using the following five step process:

1. Estimate the composition of water which would be found in selected slough and bay segments under existing (i.e., no circulation) and ISP conditions - the estimated composition for a given segment specifies the percentage of each type of water present in the segment (i.e., percentages of bay water, upstream slough water, and each type of discharged pond water)
2. Formulate these compositions by mixing, in the predicted proportions, samples of bay, slough, and pond waters actually collected from the water bodies in question at the times in question
3. Perform analytical tests (i.e., ultimate BOD analyses) on each of these mixtures to determine their oxygen demand
4. In each segment, determine how circulation of pond water during the ISP changes oxygen demand
5. Predict whether any observed changes in oxygen demand would result in adverse conditions to aquatic life

General Overview of Results - The results of the evaluations performed indicate that, for the scenarios that were evaluated, the circulation of saline pond water during the ISP will not cause adverse impacts due to reduced dissolved oxygen. The data indicate that in the "late summer-early fall" time frame, oxygen demand (determined under worst case conditions of total darkness) will be slightly higher during the ISP than under existing conditions in segments of Alviso Slough, Coyote Creek, Old Alameda Creek, Alameda Flood Control Channel, and S.F. Bay Proper. However, these worst-case estimates of elevated oxygen demand would not be of sufficient magnitude to cause anoxic conditions which would be harmful to aquatic life. If light had been provided, even these small decreases in DO would, in all likelihood, not have occurred. Likewise, in the early spring of the first year of the ISP (i.e., when circulation first begins and the salinity of the discharge from the salt ponds will be the highest), the oxygen demand contributed by the addition of circulated saline pond water is unlikely to produce anoxic conditions in the receiving waters. During this Initial Release Period, any increased oxygen demand is apparently due to the presence and respiration of algae in the pond water and with even minimal average ambient light conditions would result in no net loss of dissolved oxygen in the sloughs and nearby bay. This is illustrated in Figure 6-1, in which the consumption of DO under a variety of diurnal light regimes is presented for each of three receiving water sites.

Applicability of Results - The mixtures that were formulated and analyzed in this evaluation are not perfectly representative of the mixtures that are expected during the ISP. This difference occurs because the plans for circulating pond water have been developed as an iterative process and have changed over time. The evaluations that were performed in the Fall of 2001 and the Spring of 2002 were based on mixtures that were predicted from the applicable operation plans at those times. Since then, in order to improve project reliability and reduce the potential for environmental impacts, major changes have been made in how the circulation is designed and will be operated. Consequently, different mixtures are now predicted for the bay and slough segments than the ones tested in Fall 2001 and Spring 2002. However, in spite of these differences, the results of the earlier tests still provide information that is relevant to the current proposed operation scheme and lead to the conclusion that sags in dissolved oxygen in the sloughs and bay are highly unlikely during the currently configured ISP. The applicability of the results to the current configuration is based on two factors. First, for many of the segments considered, the formulated and analyzed mixtures had higher concentrations of pond water than is predicted under the current ISP operation plan and, therefore, the generated results would be conservative (i.e., predict higher oxygen demand than would be experienced under the current ISP operation plan). Second, sensitivity analyses were performed using the “Spring 2002” formulated samples and the results indicate that oxygen demand does not change significantly when the amount and/or salinity of pond discharge varies and, therefore, any differences in composition between the tested mixtures and those predicted under current ISP operation plans would be unlikely to significantly alter the conclusions.

7. POTENTIAL FOR IMPACTS ON SALMONID MIGRATIONS

Chinook salmon and steelhead trout spawn in several of the tributaries to the South Bay and use a few of the proposed circulation areas as migration corridors to their upstream spawning grounds. There is a concern that changes in the composition of water in the circulation areas during the ISP might disorient the salmonids and interrupt the upstream passage of adults and the downstream passage of juveniles through these critical areas. In addition, there is a concern that downstream migrating juveniles might be entrained into the salt ponds along with the circulation intake water during the ISP.

The concerns about potential impacts to salmonids were addressed in a multistep process in which (1) life history characteristics of salmonids in the relevant creeks and sloughs was determined, (2) potential impacts to upstream migrating adult salmonids were evaluated, and (3) the potential impacts to downstream migrating juvenile salmonids were evaluated. The design and results of these evaluations are described in detail in a report by S.R. Hansen & Asociates entitled "Evaluation of the Potential for Impacts on Salmonid Migration Associated with Circulation of Saline Pond Water during the Initial Stewardship Period" which can be found as an appendix to this document. A brief summary of the results is presented below.

Use of Sloughs and Creeks by Salmonids - Steelhead trout and chinook salmon use three of the sloughs into which saline pond water will be circulated during the ISP as migration corridors to upstream spawning areas. Both species currently use Coyote Creek and Alviso Slough. In addition, steelhead trout would use the Alameda Flood Control Channel if, as planned, man-made obstructions were removed. The use of these waterbodies as migration corridors is seasonal, with adult steelhead trout primarily migrating upstream from January through March and adult chinook salmon primarily migrating upstream from September through November. The young-of-the-year of both species primarily migrate downstream between March and April, with some storm-driven migration occurring as early as December.

Evaluation of Entrainment of Downstream Migrating Juveniles – Since juvenile salmonids are traveling towards the more saline waters of the South Bay and eventually the ocean, it does not seem likely that zones of elevated salinity would adversely affect their downstream migrating behavior as long as the salinity was not high enough to cause mortality or other acute impacts. However, there is a potential that the downstream migrating juveniles could be entrained into the salt ponds along with water taken from the sloughs as intake for the planned circulation patterns. Such intakes are planned for Alviso Slough (into Pond A9), Coyote Creek (into Pond A17), and Alameda Flood Control Channel (into Pond 1C). Any juvenile salmonids entrained into the salt ponds would likely be lost from the population.

To eliminate any possibility of entrainment of juvenile salmonids, it was decided in consultation with NMFS to close the intakes on all salmonid creeks and sloughs from December 1 through April 30. This period encompasses the peak downstream juvenile migration period (March through April) as well as any early storm-induced juvenile washouts (late December through February). This closure period may be shortened by one month (i.e., December 1 – March 31) for the A9 intake from Alviso Slough during the Initial Release Period in order to prevent higher than desired salinities in the A14 discharge.

Evaluation of Interference with Upstream Migration of Adults – Upstream migrating adult steelhead trout and adult chinook salmon are both thought to be following a chemical signal to their spawning areas. The exact nature of this signal is not known, but is thought to be associated with some mixture of water-borne chemical constituents which are unique to the stream in which they were born and to which they are returning to spawn. It has been suggested that for upstream migration to be successful, there should be an increasing concentration of this chemical signal as the adults move upstream in the sloughs and streams leading to the spawning areas. Since the exact chemical compounds that serve as signals for the upstream migration have not been identified, it is reasonable to assume that maintenance of a "natal-stream water" gradient (i.e., concentration of natal-stream water increases as an adult salmonid moves further upstream) may be a reasonable surrogate. If the circulation of pond water during the ISP interrupts this "natal-stream water" gradient, upstream migration of chinook salmon and/or steelhead trout could be impaired.

It has also been hypothesized that a decreasing salinity gradient might be playing a role in guiding salmonids to their upstream spawning areas. Consequently, significant interruptions in these salinity gradients in the sloughs and creeks used by steelhead trout and chinook salmon as migration corridors might impair their upstream migrations.

"Natal-Stream Water" Gradient Evaluation - An evaluation was performed to determine whether the circulation of saline waters from the salt ponds during the ISP would interfere with the "natal-stream" gradient in the sloughs and creeks used by salmonids as migration corridors to their upstream spawning areas. This evaluation was targeted to those sloughs and creeks actually used by salmonids (i.e., Alviso Slough, Coyote Creek, and the Alameda Flood Control Channel) and to those times during which the peak upstream migrations actually occur (i.e., January-March for steelhead trout and September-November for chinook salmon).

The evaluation consisted of three components. First, the three sloughs used by salmonids as migration corridors were each divided into 1-km segments. Second, using modeling techniques, the percentage of various types of water (i.e., upstream "natal-stream" water, bay water, saline pond water) in each segment was predicted under both existing and ISP conditions. Third, the existing condition and ISP condition predictions were compared to determine if discharge from the ponds during the ISP would produce a break in the "natal-stream gradient" and, if so, whether adult salmon migration would be adversely impacted.

The results of these evaluations indicate that circulation of saline water during the ISP is not expected to disrupt the "natal-stream" gradients in the sloughs and creeks used by adult salmonids as migration corridors to their upstream spawning areas. In all cases examined, the magnitude of the gradient will not decrease due to the addition of saline pond water and adult steelhead trout and adult chinook salmon should have a strong "natal-stream" signal to follow to their spawning grounds. The maintenance of a "natal-stream water" gradient during the ISP is illustrated in Figure 7-1 for Alviso Slough and Coyote Creek during both the fall and winter upstream migration periods and for AFCC during just the fall upstream migration period.

Salinity Gradient Evaluation - The salinity in a tidal slough generally increases in the downstream direction. Therefore, the salinity at any given point in a tidal slough is usually lower than the salinity at any point further downstream (toward the bay). Discharges from salt ponds during the ISP could lead to localized regions, near the salt pond system outlets, where there are maxima in salinity. When passing through such a local maxima, an upstream migrating adult salmonid would experience a local "salinity gradient reversal" (i.e., lower salinity to higher salinity to lower salinity). The effect that such a local "salinity gradient reversal" would have on upstream migrating adult salmonids is not known, but there is, at least theoretically, a possibility that it could confuse a fish and impede its upstream migration.

It should be noted that salinity gradient reversals occur naturally in San Francisco Bay and do not appear to hinder the upstream migration of adult salmonids. Salinity data collected for the South Bay Discharge Authority between December 1981 and November 1986 (Kinnetic Laboratories 1987) suggests that salinity reversals occur regularly and naturally in both Alviso Slough and Coyote Creek. In addition, the salinity observation data collected by the USGS for the South San Francisco Bay (Baylosis et al. 1997) demonstrate that there are reversals in the salinity gradient in the South Bay during periods of salmonid migrations. Since salmonids are known to navigate successfully through the South Bay, Coyote Creek, and Alviso Slough during these periods, it is reasonable to assume that these natural reversals do not impede the migratory pathways of the salmonids.

Despite the uncertainty as to the importance of salinity gradients in salmon migratory behavior, an evaluation was performed to determine whether the circulation of saline waters from the salt ponds during the ISP might interrupt the salinity gradient in the sloughs and creeks used by salmonids as migration corridors to their upstream spawning areas. This evaluation was targeted to those sloughs and creeks actually used by salmonids (i.e., Alviso Slough, Coyote Creek, and Alameda Flood Control Channel) and to those times during which the peak upstream migrations actually occur (i.e., January-March for steelhead trout and September-November for chinook salmon).

The evaluation consisted of three components. First, for each slough and relevant time period, mathematical modeling techniques were used to predict salinity gradients under existing conditions (i.e., no pond circulation). Second, using the same models, salinity gradients were predicted under ISP conditions. Third, these existing condition and ISP condition gradients were compared to determine if discharge from the ponds during the ISP would produce significant salinity gradient reversals. It should be noted that the identification of salinity gradient reversals is dependent upon the threshold that is used – i.e., how much more saline does the upstream water have to be in order for a gradient reversal to be considered reportable. In this evaluation, two threshold values were used: 3 ppt and 1 ppt. The 3 ppt threshold is considered representative of what might be reasonably detected by salmonids and might potentially influence their behavior. The 1 ppt threshold is considered a very conservative prediction of a salinity gradient reversal and is unlikely to have an influence on salmonid migratory behavior.

The results of these evaluations indicate that circulation of saline water during the ISP will not significantly disrupt salinity gradients in the sloughs and creeks used by adult salmonids as migration corridors to their upstream spawning areas. During the winter months when steelhead trout are migrating upstream, model predictions based on the 3 ppt threshold indicate that for the two streams currently used (i.e., Alviso Slough and Coyote Creek) and the one stream that could potentially be used (i.e., Alameda Flood Control Channel), salinity gradients would be intact for more than 99% of the time during the ISP. During the fall months when chinook salmon are migrating upstream, model predictions indicate that for Coyote Creek, salinity gradients would be intact for 100% of the time during the ISP. For Alviso Slough, even though the modeling predicts a greater frequency and duration of salinity gradient reversals during this fall period, intact salinity gradients on a monthly basis are still predicted to exist for between 49 and 98% of the time. It should be noted that all predicted salinity gradient reversals were geographically limited to a relatively small area in each slough around the point of discharge from the salt pond. In addition, many of the predicted "salinity gradient breaks" only affect the lower portion of the water column and, therefore, in these cases, a zone of passage with an intact salinity gradient is present in the upper portion of the water column. The model predictions indicate that during the ISP salinity gradients are sufficiently intact to provide a consistent signal for upstream migration, if, indeed, the steelhead trout and chinook salmon actually follow such a signal.

8. POTENTIAL FOR IMPACTS ON BAY SHRIMP HABITAT

Bay shrimp (*Crangon franciscorum*) is a common invertebrate species in South S.F. Bay and its tributaries. At present, there is a commercial fishery for this species in the South Bay and the juveniles of this species live in probably all of the sloughs into which saline pond water would be circulated during the ISP. Reportedly, these juveniles have specific salinity requirements which are currently being met in South Bay sloughs and creeks. There is a concern that the circulation of saline pond water during the ISP will increase salinities in the sloughs to levels that are outside the requirements of the bay shrimp and, consequently, will adversely impact the bay shrimp population.

The concerns about potential impacts to bay shrimp was addressed in a multistep process in which (1) life history characteristics of bay shrimp in the sloughs in question were determined, (2) the salinity preferences of various life stages of bay shrimp were estimated, (3) salinity profiles in each slough over the course of the year were predicted under existing and ISP conditions, and (4) changes in habitat quality due to pond discharge (based on how well salinity profiles matched salinity preferences) were estimated. The design and results of these evaluations are described in detail in a report by S.R. Hansen & Associates entitled "Evaluation of the Potential for Impacts on Bay Shrimp Associated with Circulation of Saline Pond Water during the Initial Stewardship Period" which can be found as an appendix to this document. A brief summary of the results is presented below.

Use of Sloughs by Bay Shrimp - Bay shrimp use all of the sloughs into which saline pond water will be circulated during the ISP as rearing habitat. The use is seasonal, with most shrimp being absent during the months of March and April, when adults migrate to the ocean to spawn (Figure 8-1). Starting in May, juveniles migrate to the sloughs from the ocean and apparently seek out slough segments based on prevailing salinity profiles. As the shrimp grow and mature, they are found in those segments of the sloughs that contain higher salinity waters (i.e., closer to the bay). In January and February, when the shrimp are mostly adults, they leave the sloughs and begin their annual migration to their ocean spawning grounds. It should be noted, that one of the reasons that the Initial Release Period was selected to begin on April 1 is to take advantage of this window of low shrimp abundance in the sloughs and, consequently to minimize any potential impacts to this commercially fished species.

Salinity Preferences – In the South Bay and its tributaries, the salinity preference of bay shrimp is apparently associated with the age and, correspondingly, the size of the individuals. Juvenile bay shrimp (defined as individuals between 11 and 25 mm total length) are found in South Bay sloughs from May (when they first arrive from the ocean) through August (after which they are considered adults). As illustrated in Figure 8-2, CDF&G data indicates that the juveniles are found in waters of between 3 and 19 ppt salinity, but seem to prefer a salinity range of 10 and 15 ppt (Baxter et al. 1999).

As the bay shrimp get older and larger, they are found in higher salinity waters (Baxter et al 1999, Kinnetic Labs 1987). In the months of September through February, the average size of the adult bay shrimp in the potential circulation areas consistently increases from 30 mm to almost 50 mm. In the main channel of South Bay, bay shrimp in this size range are commonly found in waters with average salinities of between 17 and 27 ppt (depending upon year), and at maximum salinities as high as 32 ppt. In the sloughs, from September through December, the adult shrimp are found in waters of between 4 and 27 ppt, but seem to prefer a range of between 10-20 ppt.

Evaluation of Potential Impacts – As discussed in Section 1 of this report, three operation plans are now being considered for the initial release portion of the ISP. Each of these plans creates a different salinity profile in the sloughs and, consequently, a different exposure for the resident bay shrimp. Therefore, separate evaluations were performed for each scenario.

Based on the salinity preferences of the various life stages of bay shrimp and model predictions of salinity profiles, it appears that, if the discharges commence in April at salinities observed in 2002, the circulation of saline water from the ponds will not significantly alter the overall habitat value for bay shrimp in the sloughs in question (Table 8-1). For all four sloughs examined, the amount of preferred habitat for the adults is predicted to remain unchanged or, in the case of Guadalupe Slough, increase during the ISP. Similarly, for three of these four sloughs, the amount of preferred habitat for juveniles will remain relatively unchanged during the ISP. In Alviso Slough, where there is a predicted decrease in the amount of preferred juvenile habitat area (i.e., Alviso Slough), the resulting habitat value may be decreased, but would not be eliminated.

If the discharges commence in April at their proposed maximum salinities, conclusions on potential impacts to bay shrimp habitat do not change significantly (Table 8-2). Under these conditions, there is no predicted reduction in the amount of adult preferred habitat area in any of the four sloughs studied. In addition, for two of the sloughs (the Alameda Flood Control Channel and Guadalupe Slough) there is no predicted reduction in the amount of juvenile preferred habitat either. On the other hand, for Alviso Slough and Coyote Creek, discharges under these conditions are predicted to reduce the amount of preferred juvenile habitat, but the lost area will still retain some value to the juvenile shrimp. It should be pointed out that, according to these predictions, increasing the discharge salinities from 2002 levels to maximum proposed levels resulted in relatively little additional habitat loss for bay shrimp.

If the discharges commence in July at their proposed maximum salinities, conclusions on potential impacts to bay shrimp habitat change to a greater extent (Table 8-3). Under these conditions, there is no predicted reduction in the amount of adult preferred habitat in any of the three sloughs studied. In addition, for Coyote Creek there is little predicted change in the amount of juvenile preferred habitat either. On the other hand, for Alviso Slough and Guadalupe Slough, discharges under these conditions are predicted to reduce the amount of preferred juvenile habitat. However, it should be noted that even though some habitat in these sloughs will now fall out of the preferred juvenile salinity range, this habitat will still maintain some value to juvenile bay shrimp.

Overall Conclusions - In summary, this evaluation indicates that, with regard to bay shrimp habitat, the major change that the circulation of saline pond water will produce during the ISP is a shift of the preferred salinities to locations further upstream in the sloughs in question. Overall, if discharges are at 2002 salinities, the amount of habitat that will have the preferred salinity ranges for both juveniles and adults will not decrease. If the discharges are at proposed maximum salinities (with the initial release beginning in either April or July), there is a predicted decrease in juvenile preferred habitat in Alviso Slough and Guadalupe Slough during the Initial Release Period, but adult preferred habitat is not expected to be affected. After the initial release from the ponds has been completed, it is anticipated that juvenile and adult shrimp habitat in the sloughs will not be significantly impacted by the planned continuous circulation of relatively low salinity pond water.

It is clear that bay shrimp use the sloughs into which saline pond water will be circulated during the ISP as rearing habitat. The use is seasonal, with most shrimp being absent during the months of March and April. This two month period encompasses the time when the adults leave the South Bay to spawn in the ocean. In May, the young-of-the-year return to the sloughs to grow and mature until February when their annual migration to the ocean once again begins. In order to minimize any potential impacts to bay shrimp, this window of low abundance (March and April) would be an ideal time to initiate the circulation of saline water from the ponds. The discharged pond water will have the highest salinities at the beginning of the ISP and an opportunity to eliminate those more saline waters when the majority of the shrimp are absent would be advantageous.

9. ESTIMATED TIME TO RECOVERY

Any adverse impacts to the resident invertebrate and/or fish community in the South Bay and its tributaries during the ISP would most likely occur during the Initial Release Period when the salinity, metals concentrations, and oxygen demand of the discharges would be the highest. However, due to the relatively short duration of the Initial Release Period (i.e., approximately two months for the bulk of the highly saline water to be pushed through the ponds), the highest risk to the aquatic community will be relatively short-lived and recovery from impacts, if any occurred, will begin rather quickly.

The available literature suggests that, if adversely impacted, benthic invertebrate communities in the discharge areas would begin recovering almost immediately after the completion of the Initial Release Period, with close to original community structure being re-established within one year. Over a 10-year period (1974-83), Nichols and Thompson (1985) studied benthic invertebrate communities in South San Francisco Bay mudflats. These communities are probably very similar to those found in many of the bay and slough segments which will receive salt pond discharges during the ISP. Nichols and Thompson report that these communities are very persistent over time because many of the member species can respond quickly to major changes in salinity and other perturbations. During these perturbations, local populations of some of the resident species may greatly diminish in numbers or even disappear. However, when favorable conditions return, these species often become re-established within a matter of months. According to Nichols and Thompson, the key to this rapid recovery are the “opportunistic life history strategies (rapid maturity, brooding of young, multiple generations each year, ease of local dispersal of both juveniles and adults) that permit continued colonization of the mudflat surface or rapid re-colonization after disturbances”.

A second study by Hopkins (1987), reported similar findings for four intertidal sites in San Francisco Bay. Two of these sites, near Palo Alto and near Hayward, are in the general area of the proposed Alviso and Baumberg Unit discharges and would be expected to have similar benthic invertebrate community structure. Over a two year period, the benthic invertebrate community structure varied considerably at each of these sites due to changes in salinity resulting from changing rainfall patterns. The fall of 1982 to the spring of 1983 was an unusually wet period and many of the species that are commonly found in the study areas were lost from the benthic communities. However, during the following year, rainfall was back to normal and many of the “lost” species were re-established.

Other corroborating information on the ability of estuarine species to rapidly become re-established can be found in the literature on the colonization of constructed salt wetlands. This process is clearly a worst-case example because, when initially constructed, the ecosystem in these wetlands is starting from scratch. Not only are there no estuarine animals or plants present, but the physical habitat is still being modified. In a paper by Levins et al. (1996), it is reported that one month after the creation of a salt marsh, there is early colonization of benthic invertebrates and after six months the macrofaunal densities and species richness of sediments resemble those of natural marshes. Similarly, Simenstad and Thom (1996) report that in created wetlands, fishes immediately occupied the intertidal habitat, with the number of species present during the first year being fairly equivalent to later years.

Other information which demonstrates the ability of natural benthic invertebrate communities to recover from major perturbations includes the accidental spill of metam sodium, a toxic soil sterilant, into the Upper Sacramento River at the Cantara Loop in July 1991. According to a Department of Water Resources report (DWR 1997), immediately after this accident, the benthic invertebrate community was totally eliminated for a 26-mile stretch downstream of the Cantara Loop. However, within 30 days, colonization of the entire impacted area was significantly underway and within 4 months, the diversity found at the impacted sites was similar to that found at the upstream control area. Within one year, most metrics of benthic community health indicated recovery at the downstream sites.

10. LITERATURE CITED

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Table 4-1. Estimated Range of Salinities at Each Discharge Point

Discharge Point	Estimated Range of Salinities at Discharge Point (ppt) during:			
	Initial Release Period: (at 2002 Salinities) Beginning on April 1 (first 2 months)	Initial Release Period: (at Proposed Max Salinities) Beginning on April 1 (first 2 months)	Phased Initial Release Period: (at Proposed Max Salinities) Beginning on July 1 (first 2 months)	Continuous Circulation Period
Alviso Unit				
A2W	27 - 31	27 - 65	45 - 65	14 - 44
A3W	28 - 31	27 - 65	43 - 65	14 - 44
A7	27 - 51	26 - 110	41 - 110	12 - 44
A14	36 - 75	36 - 100		20 - 44
A16	44 - 83	29 - 135		15 - 44
A19, A20, A21		29 - 135		15 - 44
Baumberg Unit				
2	30 - 37	30 - 65	45 - 65	18 - 44
11	25 - 35	28 - 65	40 - 65	15 - 44
2C	30 - 37	32 - 100		18 - 44
8A	48- 98	74 - 135	35 - 135	20 - 44
6A		28 - 135		16 - 44
West Bay Unit				
SF-2		28 - 135		16 - 44
5S		28 - 135		16 - 44

Table 4-2. Species with Demonstrated Tolerances to High Salinities (from Hopkins 1973)

Taxa	Species	Upper Salinity Tolerance (ppt)	Reference
Invertebrates			
Grapsoid crabs	*Macrophthalmus crassipes*	50-70	Barnes, R.S.K. 1967
	Mictyris longicarpus		
	Macrophthalmus setosus		
	Paracleistostoma mcneilli		
Brine shrimp	*Artemis salina*	192	Croghan, P.C. 1958
Polychaete annelid	*Cirriforma spirabrancha*	40	Dice, J.F. 1969
Isopod	*Limnoria*	48	Eltringham, S.K. 1961
Shrimp	*Crangon crangon*	50	Flugel, H. 1966
Mussel	*Mytilus californianus*	48	Fox, D.L. 1941
Shrimp	*Crangon septemspinosa*	39	Haefner, P.A. 1969
Prawn	*Palaemonetes varians*	66	Lofts, B. 1956
Amphipod	*Corophium volutator*	50	McLusky, D.S. 1967
Mussel	*Mytilus edulis*	50	Motwani, M.P. 1955
Copepod	*Trigriopus fulvus*	90	Ranade, M.R. 1957
Flatworm	Monocelis fusca	120	Rees, O. 1941
Mollusk	*Littorina rudis*	64	
Mollusk	*Patella vulgata*	64	
Fish			
Sculpin	*Oligocottus snyderi*	50	Courtright, R.C. & Bond, E. 1969
Plaice	*Pleuronectes platessa* larvae	45-60	Holliday, F.G.T. 1967
Tilapia	*Tilapia mossambica*	64	Ramamurthi, R. 1965
Plants			
Seaweed	*Enteromorpha clathrata*	93	Biebl, R. 1956
Shoalgrass	*Diplanthera wrightii*	>44	McMahan, C.A. 1968.
Manateegrass	*Syringodium filiforme*	44	
Spermatophytes	*Thalassia testudinum*	74	McMillan, C & Moseley, F.N. 1967
	Halophila engelmanni	74	
	Diplanthera wrightii	74	
	Ruppia maritima	46	
	Syringodium filiforme	45	

Table 4-2. Species with Demonstrated Tolerances to High Salinities

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Table 5-1. Applicable Water Quality Objectives for Receiving Waters in Vicinity of Pond Discharges

Metal	Objective for South of Dumbarton Bridge[a] (ug/l)		Objective for North of Dumbarton Bridge[c] (ug/l)	
Arsenic	36	Dissolved	36	Total
Cadmium	9.3	Dissolved	9.3	Total
Chromium	50	Dissolved	50	Total
Copper	6.9[b]	Dissolved	5.3[d]	Dissolved
Lead	8.1	Dissolved	5.6	Total
Mercury	0.050	Total	0.025	Total
Nickel	11.9	Dissolved	7.1	Total
Selenium	5.0	Total	5.0	Total
Silver	1.9	Dissolved	2.3	Total
Zinc	81	Dissolved	58	Total

a - all objectives except for copper and nickel are as stated in the California Toxics Rule (40CFR 131.38)
b - copper and nickel site-specific objectives developed by S.F. Regional Water Quality Control Board
c - all objectives except for copper are as specified in the S.F. Bay Basin Plan 6/95
d - copper site-specific objective being considered by S.F. Regional Water Quality Control Board

Table 5-2. Measured Metal Concentrations in Water Column Samples Collected from South Bay Salt Ponds on 10/24/02[a]

Pond ID	Salinity (g/L)	Dissolved Concentration Cr (ug/l)	Dissolved Ni (ug/l)	Dissolved Cu (ug/l)	Dissolved Zn (ug/l)	Dissolved As (ug/l)	Total Recoverable Concentration Cr (ug/l)	Total Recoverable Ni (ug/l)	Total Recoverable Cu (ug/l)	Total Recoverable Zn (ug/l)	Total Recoverable As (ug/l)
A2W	31.6	1.22	8.05	1.06	1.21	6.27	2.36	11.8[d]	2.15	1.8	6.36
A3W	42	1.22	7.45	1.10	0.65	10.7	0.67	8.42[d]	1.24	0.79	11.9
B2C	54.6	1.24	4.96	1.29	1.18	1.14	0.67	7.09	1.59	1.28	1.0
A15	89.4	1.12	10.8[c]	0.86	1.29	14.0	0.83	14.3[d]	1.37	1.82	15.1
A15 (Dup)	89.8	1.16	10.6	0.89	1.83	14.5	1.07	15.7[d]	1.59	3.07	15.7
A14	92.6	1.35	11.0[c]	0.97	1.15	18.3	1.17	13.5[d]	2.04	3.16	20.1
A16	109	1.27	12.8[c]	1.07	2.25	14.4	1.23	18.1[d]	2.01	3.38	17.1
A18	146	1.35	19.7[c]	1.92	2.88	48.3	1.30	21.8[d]	3.39	4.49	56.2
I-3[b]	194	1.16	10.8[c]	0.57	2.87	3.52	1.47	9.73[d]	2.07	6.77	4.28
I-3B[b]	224	1.47	13.3[c]	2.64	4.02	3.14	1.38	12.3[d]	2.45	7.22	5.18
B9	279	1.34	14.5[c]	2.21	3.80	30.9	1.12	15.1[d]	2.61	4.28	33.1

Pond ID	Salinity (g/L)	Dissolved Concentration Se (ug/l)	Dissolved Ag (ug/l)	Dissolved Cd (ug/l)	Dissolved Hg (ng/l)	Dissolved Pb (ug/l)	Total Recoverable Concentration Se (ug/l)	Total Recoverable Ag (ug/l)	Total Recoverable Cd (ug/l)	Total Recoverable Hg (ng/l)	Total Recoverable Pb (ug/l)
A2W	31.6	0.199	0.012	0.049	1.26	0.264	0.274	0.022	0.063	11.8	0.843
A3W	42	0.128	0.010	0.044	1.26	0.307	0.173	0.015	0.045	4.78	0.324
B2C	54.6	0.055	0.016	0.054	0.36	0.280	0.092	0.013	0.050	3.37	0.392
A15	89.4	0.094	0.021	0.077	1.38	0.313	0.160	0.030	0.054	32.0[e]	0.351
A15 Dup	89.8	0.124	0.027	0.067	1.28	0.330	0.135	0.020	0.054	32.0[e]	0.371
A14	92.6	0.111	0.055	0.039	2.21	0.309	0.220	0.063	0.053	44.5[e]	0.395
A16	109	0.141	0.040	0.053	1.40	0.446	0.159	0.150	0.062	39.5[e]	0.619
A18	146	0.224	0.023	0.899[a]	1.14	0.748	0.310	0.045	0.119	49.7[e]	1.37
I-3[b]	194	0.304	0.015	0.096	0.56	0.572	0.295	0.128	0.119	35.6[e]	0.892
I-3B[b]	224	0.142	0.039	0.124	0.69	1.33	0.352	0.044	0.136	41.0[e]	1.15
B9	279	0.140	0.028	0.423	0.41	7.18	0.143	0.416	0.123	30.0[e]	6.48

[a] Possible laboratory contaminination suspected by Frontier Geoscience

a - Samples collected by S.R. Hansen & Associates and Analyzed by Frontier Geoscience in Seattle, Washington
b - Ponds I-3 and I-3B are part of Cargill's Plant 1 unit and are located immediately south of the Dumbarton Bridge.
These ponds are not part of the sale, but would have water quality representative of ponds in the sale with similar salinities.
c - Measured values exceed site-specific WQO for So. Bay of 10.8 ug/l (dissolved Ni); applicable to Alviso Ponds discharge
d - Measured values exceed Basin Plan WQO of 7.1 ug/l (total Ni); applicable to Baumberg and West Bay Ponds discharge
e - Measured values exceed Basin Plan WQO of 25 ng/l (total Hg); applicable to Baumberg and West Bay Ponds discharge

Table 5-3. Comparison of Estimated Nickel Concentrations in Discharges vs WQOs

Discharge Point	Period of Interest	Predicted Salinity of Discharge (ppt)	Estimated Range of Discharge Concentrations Dissolved Ni (ug/l)	Estimated Range of Discharge Concentrations Total Ni (ug/l)
Applicable Limits			**11.9**	**7.1**
Alviso Ponds				
All Ponds	Continuous Circulation	12 - 44	3.1 - 8.05	
A2W	Initial Release (2002 Salinity)	27 - 31	3.1 - 8.05	
	Initial Release (Max Salinity)	27 - 65	4.96 - 10.8	
A3W	Initial Release (2002 Salinity)	28 - 31	3.1 - 8.05	
	Initial Release (Max Salinity)	27 - 65	4.96 - 10.8	
A7	Initial Release (2002 Salinity)	27 - 51	4.96 - 7.45	
	Initial Release (Max Salinity)	26 - 110	4.96 - **12.8**	
A14	Initial Release (2002 Salinity)	36 - 75	4.96 - 10.8	
		36 -100	4.96 - **12.8**	
A16	Initial Release (2002 Salinity)	44 - 83	4.96 - 10.8	
	Initial Release (Max Salinity)	29 - 135	4.96 - **19.7**	
A19, A20, A21	Initial Release (Max Salinity)	29 - 135	4.96 - **19.7**	
Baumberg Unit				
All Ponds	Continuous Circulation	15 - 44		5.83 - **11.8**
2	Initial Release (2002 Salinity)	30 - 37		**8.42 - 11.8**
	Initial Release (Max Salinity)	30 - 65		7.09 - **15.7**
10	Initial Release (2002 Salinity)	25 - 35		5.83 - **11.8**
	Initial Release (Max Salinity)	28 - 65		7.09 - **15.7**
2C	Initial Release (2002 Salinity)	30 - 37		**8.42 - 11.8**
	Initial Release (Max Salinity)	32 - 100		7.09 - **18.1**
8A	Initial Release (2002 Salinity)	48 - 98		7.09 - **11.8**
	Initial Release (Max Salinity)	74 - 135		7.09 - **21.8**
6A	Initial Release (Max Salinity)	28 - 135		7.09 -**21.8**
West Bay Unit				
All Ponds	Continuous Circulation	15 - 44		5.83 - **11.8**
SF-2	Initial Release (Max Salinity)	28 - 135		7.09 - **21.8**
5S	Initial Release (Max Salinity)	28 - 135		7.09 - **21.8**

Table 5-4. Comparison of Estimated Mercury Concentrations in Discharges vs WQOs

Discharge Point	Period of Interest	Predicted Salinity of Discharge (ppt)	Estimated Range of Discharge Concentrations Total Hg (ng/l)	Total Hg (ng/l)
Applicable Limits			**51**	**25**
Alviso Ponds				
All Ponds	Continuous Circulation	12 - 44	4.78 - 23.9	
A2W	Initial Release (2002 Salinity)	27 - 31	11.8 - 23.9	
	Initial Release (Max Salinity)	27 - 65	3.37 - 32	
A3W	Initial Release (2002 Salinity)	28 - 31	11.8 - 23.9	
	Initial Release (Max Salinity)	27 - 65	3.37 - 32	
A7	Initial Release (2002 Salinity)	27 - 51	3.37 - 11.8	
	Initial Release (Max Salinity)	26 - 110	3.37 - 44.5	
A14	Initial Release (2002 Salinity)	36 - 75	3.37 - 32	
		36 -100	3.37 - 44.5	
A16	Initial Release (2002 Salinity)	44 - 83	3.37 - 32	
	Initial Release (Max Salinity)	29 - 135	3.37 - 49.7	
A19, A20, A21	Initial Release (Max Salinity)	29 - 135	3.37 - 49.7	
Baumberg Unit				
All Ponds	Continuous Circulation	15 - 44		4.78 - 16
2	Initial Release (2002 Salinity)	30 - 37		4.78 - 11.8
	Initial Release (Max Salinity)	30 - 65		3.37 - **32**
10	Initial Release (2002 Salinity)	25 - 35		4.78 - 16
	Initial Release (Max Salinity)	28 - 65		3.37 - **32**
2C	Initial Release (2002 Salinity)	30 - 37		4.78 - 11.8
	Initial Release (Max Salinity)	32 - 100		3.37 - **44.5**
8A	Initial Release (2002 Salinity)	48 - 98		3.37 - **44.5**
	Initial Release (Max Salinity)	74 - 135		3.37 - **49.7**
6A	Initial Release (Max Salinity)	28 - 135		3.37 - **49.7**
West Bay Unit				
All Ponds	Continuous Circulation	15 - 44		4.78 - 16
SF-2	Initial Release (Max Salinity)	28 - 135		3.37 - **49.7**
5S	Initial Release (Max Salinity)	28 - 135		3.37 - **49.7**

Table 6-1 Water Quality Measurements on Pond Samples Collected Nov. 7-9, 2000

Pond	Depth (feet)	Salinity (ppt) Upwind	Salinity (ppt) Mid	Salinity (ppt) Downwind	D.O. (mg/l) Upwind	D.O. (mg/l) Mid	D.O. (mg/l) Downwind	5-dayBOD (mg/l)
A1	1	14.4	14.5	15.1	8.45	8.6	8.55	11
A15	0	62.5	62.6			8.65		22
	1	62.7	62.7	62.6	8	8.65	8.35	
	2	62.6			7.65			
	3	62.7	62.7	92.6	8	8.45	8.35	
A11	0	46.9		46	5.95		8.38	30
	1	46.8	46.4	46.1	5.9	6.65	7.5	
	4			46.2			6.2	
B1	0		28.5	29.1		7.8	7.45	
	1	28.5	28.5	29.2	7.15	7.59	7.3	
B7	0	35.2	35.3	35.3	8.2	7.88	7.68	
	1	35.2	35.4	35.4	7.8	7.79	7.45	
	2	35.2	35.4	35.4	7.85	7.55	7.55	
B3C	0	71.4	71.4	71.7	6.8		6.65	
	1	71.5	71.4		6.7	6.8		

Samples collected by Wetlands Research Associates, Inc.

Figure 6-1. Measured Oxygen Consumption in Bay and Slough Segments under Existing and Initial Stewardship Period (ISP) Conditions for Spring of First Year (i.e., Initial Release Period) - <u>Proposed Maximum Salinity Values</u>

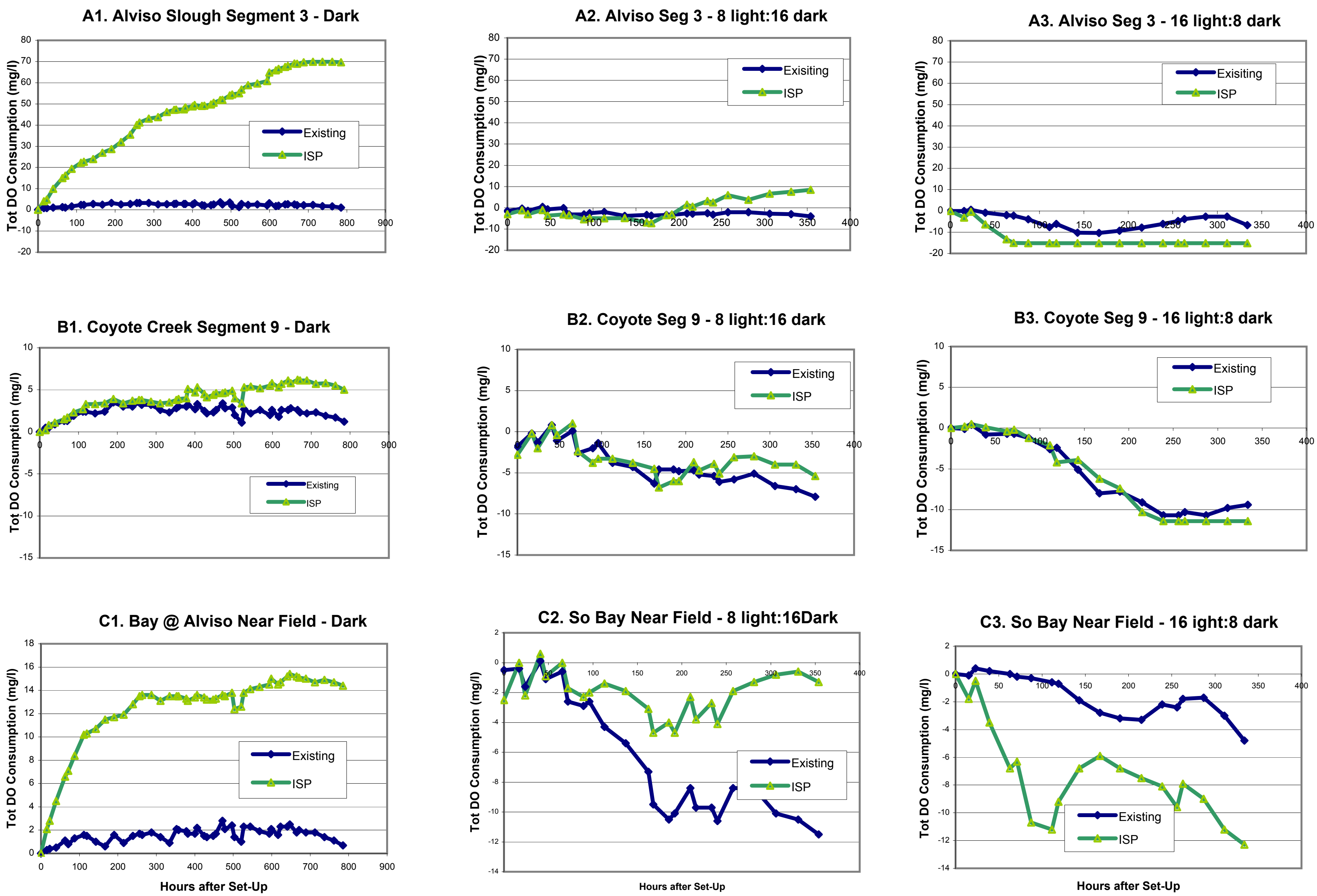
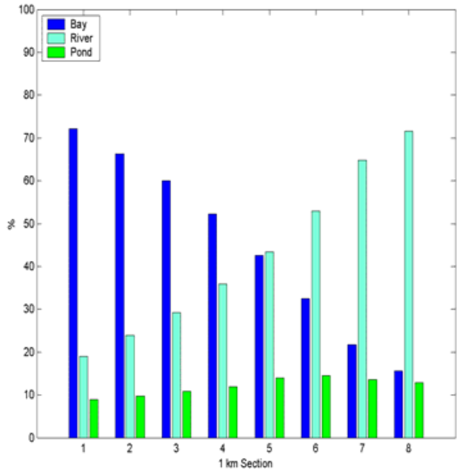
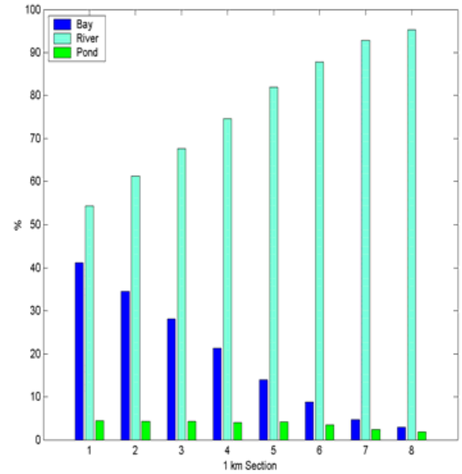


Figure 7-1. Predicted Proportions of Different Water Types along Migration Corridors under ISP Conditions during Fall and Winter Adult Salmonid Migration Runs

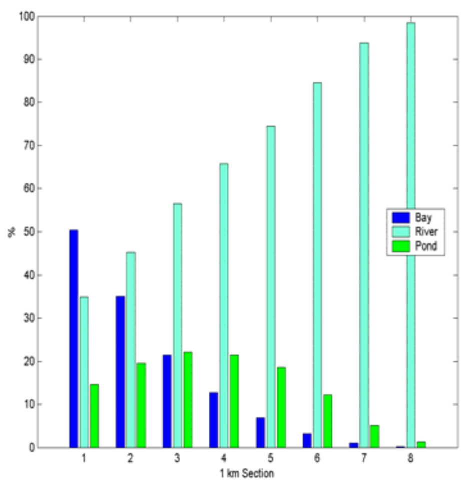
Coyote Creek - October



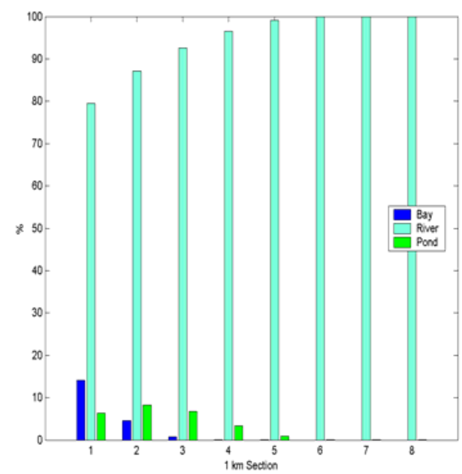
Coyote Creek - February



Alviso Slough - October



Alviso Slough - February



Alameda Flood Control - February

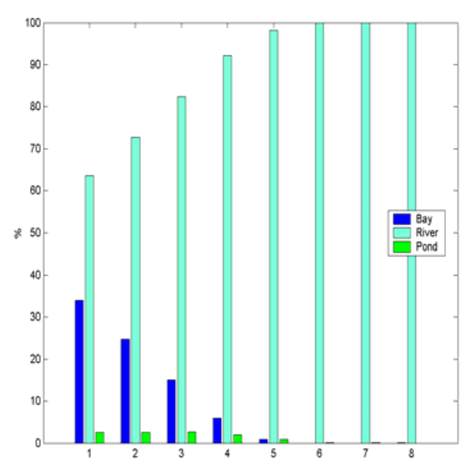


Table 8-1. Estimated Area of Preferred Bay Shrimp Habitat under Existing and Initial Stewardship Conditions (Initial Discharge at 2002 Salinities)

Month[d]	Area of Preferred Habitat (Acres)[c]							
	Alameda FCC		**Alviso Slough**		**Coyote Creek**		**Guadalupe Slough**	
	Existing	ISP	Existing	ISP	Existing	ISP	Existing	ISP
May	10.2	12.2	35	52.5	175	205	29.1	65.5
June	9.4	10.8	65.4	22.2	165	176	47.8	41.1
July	9.7	11.7	75.5	23.3	159	157	48.6	40.9
Aug	9.9	10.1	68.7	24.2	149	145	53.7	46.3
μ Juvenile[a]	**9.7**	**11**	**61.2**	**30.6**	**162**	**171**	**44.8**	**48.5**
Sept	19.6	20.2	130	50.3	307	323	79.4	90.8
Oct	18.7	19.6	87.1	88.8	310	334	68.3	91.2
Nov	26.6	27.4	62.6	86.7	405	426	61.5	138
Dec	33.9	35.2	66.2	99.7	459	469	73.4	158
Jan	25.5	25.5	17.2	20.4	554	555	39.6	50.3
Feb	46.3	47.5	5.1	6.7	597	630	16	23
μ Adult[b]	**28.4**	**29.2**	**61.3**	**58.8**	**439**	**456**	**56.4**	**91.7**

[a] **μ Juvenile = Average monthly area during May–August, when the juvenile life stage is present**

[b] **μ Adult = Average monthly area during September-February, when the adult life stage is present**

[c] **Preferred habitat is defined as the area that experiences the preferred salinity range for the lifestage; the preferred salinity range for juveniles is 10-15 ppt and for adults is 10-20 ppt**

[d] **March and April are not included because bay shrimp have low abundances in the sloughs during those months**

Table 8-2. Estimated Area of Preferred Bay Shrimp Habitat under Existing and Initial Stewardship Conditions (Initial Discharge at Maximum Proposed Salinity)

Month[d]	Area of Preferred Habitat (Acres)[c]							
	Alameda FCC		**Alviso Slough**		**Coyote Creek**		**Guadalupe Slough**	
	Existing	ISP	Existing	ISP	Existing	ISP	Existing	ISP
May	10.2	8.4	35	19.9	175	103	29.1	30.2
June	9.4	9.6	65.4	18	165	142	47.8	43.5
July	9.7	11.4	75.5	23.2	159	144	48.6	48.3
Aug	9.9	10.1	68.7	24	149	145	53.7	51.1
μ Juvenile[a]	**9.8**	**9.9**	**61.2**	**21.3**	**162**	**134**	**44.8**	**43.3**
Sept	19.6	20.2	130	52.5	307	322	79.4	85.6
Oct	18.7	19.6	87.1	88.8	310	334	68.3	91.2
Nov	26.6	27.4	62.6	86.7	405	426	61.5	138
Dec	33.9	35.2	66.2	99.7	459	469	73.4	158
Jan	25.5	25.5	17.2	20.4	554	555	39.6	50.3
Feb	46.3	47.5	5.1	6.7	597	630	16	23
μ Adult[b]	**28.4**	**29.2**	**61.3**	**58.8**	**439**	**456**	**56.4**	**91.7**

[a] μ Juvenile = Average monthly area during May–August, when the juvenile life stage is present

[b] μ Adult = Average monthly area during September-February, when the adult life stage is present

[c] Preferred habitat is defined as the area that experiences the preferred salinity range for the lifestage; the preferred salinity range for juveniles is 10-15 ppt and for adults is 10-20 ppt

[d] March and April are not included because bay shrimp have low abundances in the sloughs during those months

Table 8-3. Estimated Area of Preferred Bay Shrimp Habitat under Existing and Initial Stewardship Conditions (Phased Initial Discharge at Maximum Proposed Salinity)

Month[d]	Area of Preferred Habitat (Acres)[c]							
	Alameda FCC		Alviso Slough		Coyote Creek		Guadalupe Slough	
	Existing	ISP	Existing	ISP	Existing	ISP	Existing	ISP
May			35		175		29.1	
June			65.4		165		47.8	
July			75.5	10.4	159	136	48.6	15.6
Aug			68.7	10.4	149	128	53.7	14.4
µ Juvenile[a]			**72.1[e]**	**10.4[e]**	**154[e]**	**132[e]**	**51.1[e]**	**15.0[e]**
Sept			130	47.2	307	288	79.4	71.7
Oct			87.1	88.8	310	334	68.3	91.2
Nov			62.6	86.7	405	426	61.5	138
Dec			66.2	99.7	459	469	73.4	158
Jan			17.2	20.4	554	555	39.6	50.3
Feb			5.1	6.7	597	630	16	23
µ Adult[b]			**61.3**	**58.3**	**439**	**450**	**56.4**	**88.7**

[a] **µ Juvenile = Average monthly area during May–August, when the juvenile life stage is present**

[b] **µ Adult = Average monthly area during September-February, when the adult life stage is present**

[c] **Preferred habitat is defined as the area that experiences the preferred salinity range for the lifestage; the preferred salinity range for juveniles is 10-15 ppt and for adults is 10-20 ppt**

[d] **March and April are not included because bay shrimp have low abundances in the sloughs during those months**

[e] **µ Juvenile = Average monthly area during July-August because phased initial release does not start until July**

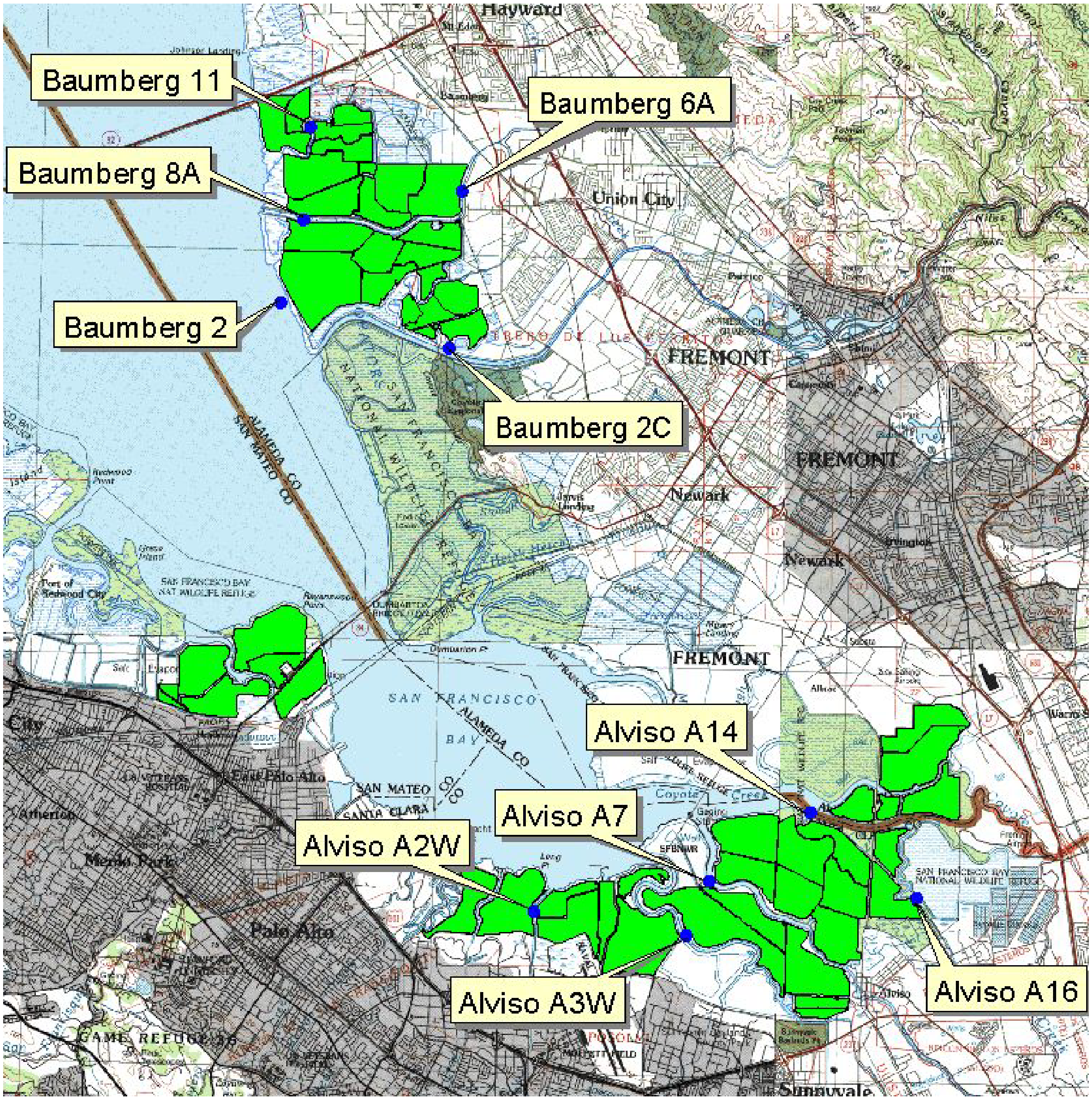


Figure 1-1. Locations of planned discharges from the Alviso and Baumberg Unit Ponds during the Initial Stewardship Period.

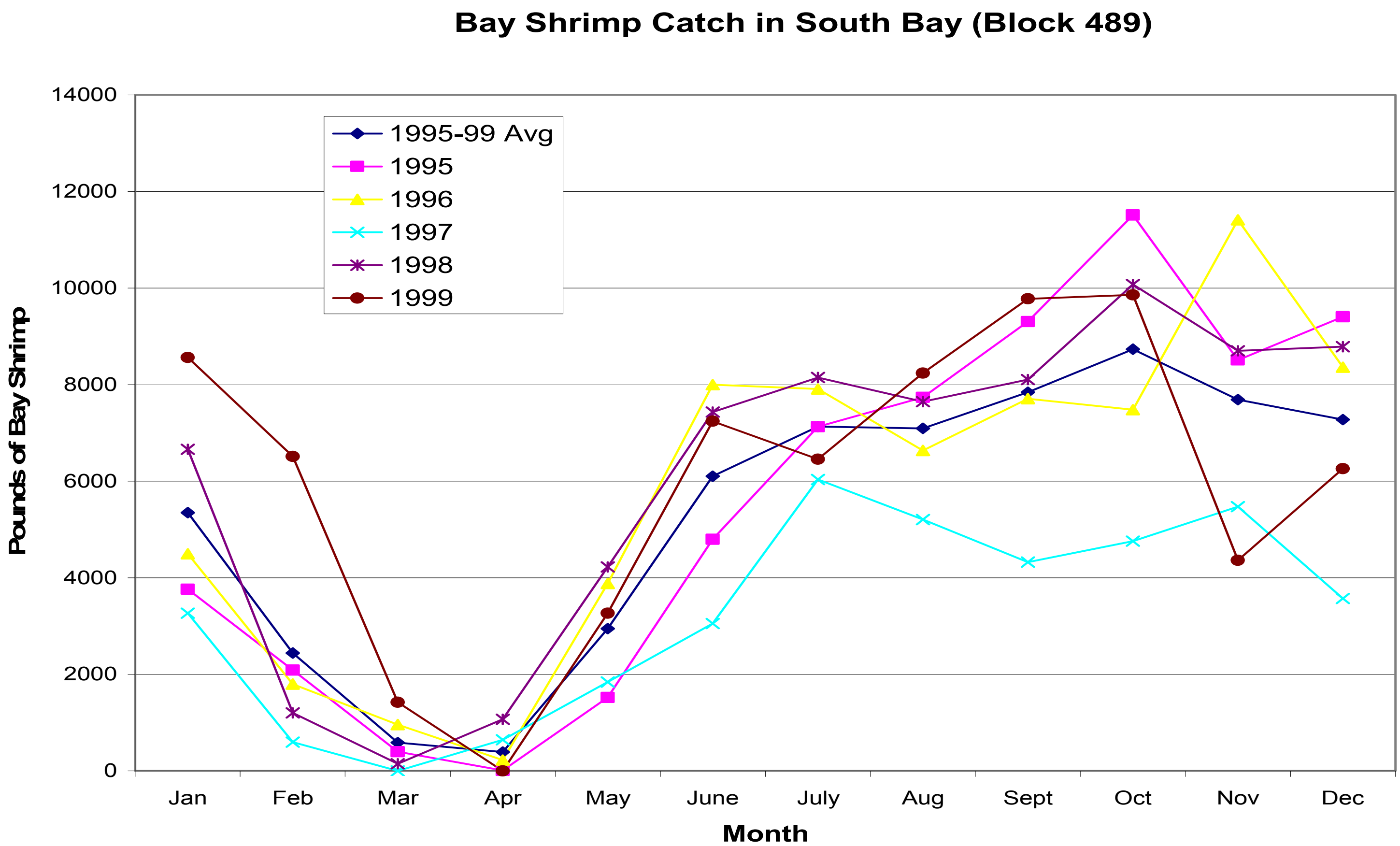


Figure 8-1. Temporal pattern of shrimp abundance in South Bay (data from S. Ashcraft, CDF&G, Belmont, CA)

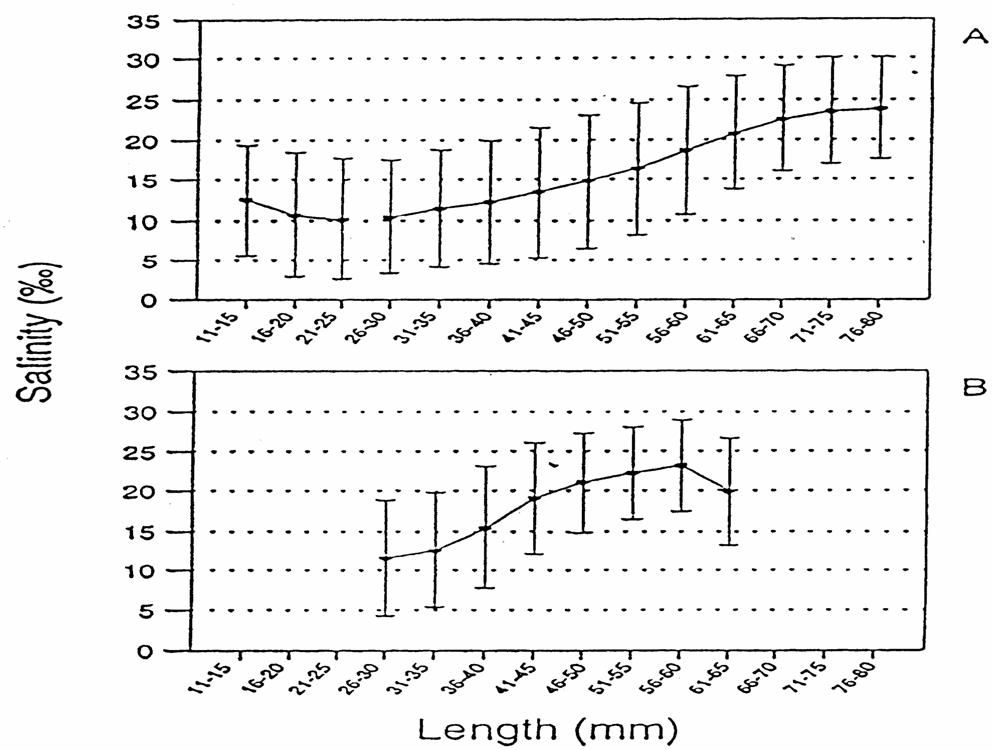


Figure 8-2. Salinity preferences for bay shrimp as a function of length
(A) For juveniles (11-25 mm) & females (26-80 mm)
(B) For males (26-65 mm)

(from Baxter et al., page 88, Figure 11)

EVALUATION OF THE POTENTIAL FOR REDUCTIONS IN DISSOLVED OXYGEN ASSOCIATED WITH CIRCULATION OF SALINE POND WATER DURING THE INITIAL STEWARDSHIP PERIOD

Prepared by
Stephen R. Hansen, Ph.D.
S.R. Hansen & Associates

1. OVERVIEW

Based on discussions with staff from California Department of Fish and Game, National Marine Fisheries Service, and the San Francisco Regional Water Quality Control Board, reductions in dissolved oxygen (D.O.) was identified as being of particular concern in potential locations where circulated pond waters would enter receiving water bodies during the Initial Stewardship Period (ISP). This concern arises from the possibility that circulated pond water may have high biological oxygen demand which could result in depressed D.O. in sloughs, creeks, and portions of the Bay proper. If these D.O. depressions were large enough, they could result in anoxic conditions that would adversely impact aquatic life.

To address this issue, an evaluation was performed to determine to what extent D.O. would be altered in selected sloughs, creeks, and bay segments as a result of saline pond water circulation during the ISP and how these alterations would affect aquatic life. This evaluation examined two periods during the ISP - (1) during "late summer-early fall", when the oxygen demand is expected to be the highest due to natural processes (i.e., high temperatures, increased organic material) and (2) during the initial release period in early spring, when the concentration of pond water would be the highest in sloughs, creeks, and bay segments. For each of these two periods, the evaluation was accomplished by a mixture of modeling and empirical efforts using the following five step process:

1. Estimate the composition of water which would be found in selected slough and bay segments under existing (i.e., no circulation) and ISP conditions - the estimated composition for a given segment specifies the percentage of each type of water present in the segment (i.e., percentages of bay water, upstream slough water, and each type of discharged pond water)
2. Formulate these compositions by mixing, in the predicted proportions, samples of bay, slough, and pond waters actually collected from the water bodies in question at the times in question
3. Perform analytical tests (i.e., ultimate BOD analyses) on each of these mixtures to determine their oxygen demand
4. In each segment, determine how oxygen demand changed as the result of pond circulation
5. Predict whether any observed changes in oxygen demand would result in adverse conditions to aquatic life

The results of the evaluations performed clearly indicate that, for the scenarios that were evaluated, the circulation of saline pond water during the ISP will not cause adverse impacts due to reduced dissolved oxygen. The data indicate that in the “late summer-early fall” time frame, oxygen demand (determined under worst case conditions of total darkness) will be slightly higher during the ISP than under existing conditions in segments of Alviso Slough, Coyote Creek, Old Alameda Creek, Alameda Flood Control Channel, and S.F. Bay Proper. However, these worst-case estimates of elevated oxygen demand would not be of sufficient magnitude to cause anoxic conditions which would be harmful to aquatic life. Likewise, in the early spring of the first year of the ISP (i.e., when circulation first begins and the salinity of the discharge from the salt ponds will be the highest), the oxygen demand contributed by the addition of circulated saline pond water is unlikely to produce anoxic conditions in the receiving waters. During this initial release period, any increased oxygen demand is apparently due to the presence and respiration of algae in the pond water and with even minimal average ambient light conditions would result in no net loss of dissolved oxygen in the sloughs and nearby bay.

It should be noted that the mixtures that were formulated, analyzed, and discussed in this report are not perfectly representative of the mixtures that are expected during the ISP. This difference occurs because the plans for circulating pond water have been developed as an iterative process and have changed over time. The evaluations presented in this paper were performed in the Fall of 2001 and the Spring of 2002 and were based on mixtures that were predicted from the applicable operation plans at those times. Since then, however, changes have been made in how the circulation would be designed and operated in order to improve project reliability and reduce the potential for environmental impacts. Consequently, different mixtures are now predicted for the bay and slough segments than are evaluated in this report. However, in spite of these differences, the results still do provide information that is relevant to the current proposed operation scheme and lead to the conclusion that sags in dissolved oxygen in the sloughs and bay are highly unlikely during the currently configured ISP. The applicability of the results to the current configuration is based on two factors. First, for many of the segments considered, the formulated and analyzed mixtures had higher concentrations of pond water than is predicted under the current ISP operation plan and, therefore, the generated results would be conservative (i.e., predict higher oxygen demand than would be experienced under the current ISP operation plan). Second, sensitivity analyses were performed using the “Spring 2002” formulated samples and the results indicate that oxygen demand does not change significantly when the amount and/or salinity of pond discharge varies and, therefore, any differences in composition between the tested mixtures and those predicted under current ISP operation plans would be unlikely to significantly alter the conclusions.

2. DETAILED EVALUATION OF EARLY FALL DISCHARGE PERIOD

The “late summer-early fall” time period was selected for evaluation because it is the most likely time of the year for sags in dissolved oxygen in South Bay sloughs and creeks to occur. Such sags have been observed to occur naturally in South Bay sloughs during this period and have been attributed to a combination of algal blooms and increased bacterial activity (Kinnetic Laboratories 1987). The experiments performed in this evaluation were based on conditions that are predicted for the “September–October” period because that is when the worst DO sags have historically been observed in South Bay sloughs.

Estimation of Segment Composition

The composition of water which would be found in selected slough and bay segments under existing and ISP conditions were estimated for the late summer and early fall months. Estimates were made for each of several slough and bay segments using mathematical modeling techniques. Fourteen segments were selected for analysis and included two locations in Guadalupe Slough, three locations in Alviso Slough, two locations in Coyote Creek, two locations in South Bay proper adjacent to the Alviso Unit (between the mouths of Guadalupe Slough and Coyote Creek), one location in Old Alameda Creek, two locations in Alameda Flood Control Channel, and two locations in S.F. Bay proper adjacent to the Baumberg Unit (between the mouths of Old Alameda Creek and Alameda Creek Flood Control Channel). The locations and identification codes for these selected segments are summarized in Table 1. Maps illustrating the locations of segments in each of the receiving waterbodies are provided in Appendix A. For each segment, the types of water and the percentages of each type that are predicted to occur under existing conditions (i.e., with no discharge of pond water) and under ISP conditions (i.e., with the discharge of pond water) are summarized in Table 2. As can be seen, under existing conditions, bay and slough segments are predicted to contain mixtures of only two types of water; originating from the bay (i.e. bay water) and originating from upstream in the sloughs and creeks (i.e., upstream water). Under ISP conditions, bay and slough segments are predicted to contain mixtures of three or more types of water; bay water and slough water plus water discharged from one or more of the salt ponds (i.e., pond waters of various salinities).

Formulation of Predicted Mixtures

Once the composition of the water in each of the slough and bay segments was predicted for existing and ISP conditions, the next step in our evaluation was to formulate these mixtures. For each segment, this was accomplished by collecting samples from all of the contributing source areas and then mixing them in the proper proportions. The sources of the various samples used in the formulations are also summarized in Table 2.

Analysis of Mixtures

Once the predicted existing and ISP mixtures were formulated, they were sent to an analytical chemistry laboratory (Columbia Analytical in Kelso, Washington) for ultimate biological oxygen demand (BOD) determinations. These BOD analyses were run according to standard protocol, with the one exception that no nutrients or bacteria were added at the start of the test. Therefore, the results of these analyses indicate how the dissolved oxygen in these mixtures would decrease over time due to the biological activity of the native bacterial and algal fauna.

Oxygen Demand of Mixtures

The results of the ultimate BOD analyses performed on the existing and ISP mixtures for each of the selected slough and bay segments are illustrated in Figure 1. These results indicate that, with the exception of the Guadalupe Slough segments, the oxygen demand slightly increases under ISP conditions. For the Guadalupe Slough segments, the oxygen demand actually decreases under ISP conditions.

Significance of Altered Oxygen Demand

For 12 out of the 14 segments evaluated for the "late summer-early fall" period, the results indicate that oxygen demand would be higher when pond water was being discharged during the ISP. However, a conservative-case evaluation (which did not consider re-aeration processes) clearly indicates that these increased DO demands would not be expected to harm aquatic life. The basis for this conclusion is explained below.

Two of the segments studied (i.e., Guadalupe Slough segments GS-3 and GS-4) did not have predicted increases in oxygen demand under ISP conditions. Obviously, adverse impacts due to decreased DO would not be anticipated in these segments as a result of pond circulation.

For all other segments investigated, a slight increase in oxygen demand is suggested by the analytical results and, therefore, at least theoretically, there was the possibility that decreased DO could become harmful to aquatic life. In order to interpret the biological significance of these anticipated increased oxygen demands, an evaluation was made for each segment to determine if the circulated pond water, with its increased oxygen demand, would remain in the segment long enough to reduce the concentration of dissolved oxygen to harmful concentrations. This evaluation, which was performed for each segment, consisted of the following three components:

1. An estimate was made of the amount of time that would be required during the circulation period for the DO in each segment to decrease to a potentially harmful concentration. This threshold for adverse impact was set at 5.0 mg/l, which is the water quality objective for DO which is established by the San Francisco Regional Water Quality Control Board for the South Bay and its' tributaries. For each segment, the estimate for "time to 5 mg/l DO" was calculated considering the initial DO of the formulated mixture and the rate of DO consumption as measured in the laboratory BOD tests.

2. An estimate was made of the average residence time of water in the segment, to establish how long the oxygen demand would be exerting its effects and, consequently, how much oxygen would be consumed prior to the water being swept into the bay and out of the system.

3. A comparison was made between the estimated "time to 5 mg/l DO" and the estimated residence time. If the estimated residence time was less than the estimated "time to 5 mg/l DO", then no adverse impact would be perdicted.

As reported in Table 3 and illustrated in Figure 2, the estimated residence time for each segment was considerably less than the "time to 5 mg/l DO" and, therefore, no adverse impacts would be anticipated during the "late summer-early fall" period due to dissolved oxygen sags.

It should be pointed out that the aforementioned evaluation was a worst case scenario because re-aeration phenomena were not considered. Under natural conditions, factors such as algal photosynthesis and wind driven mixing would tend to increase DO and neither of these processes were considered in this evaluation. Algal photosynthesis was eliminated, on purpose, by performing the BOD analyses in the dark. As will be illustrated in the next section of this report, if photosynthesis had been allowed to occur (as it would have in nature), the addition of pond water during this “late summer–early fall” period would have very likely increased dissolved oxygen, not decreased it. Wind driven re-aeration was also not considered, but, if it had been, the effect would have been to either eliminate any DO sags or significantly reduce their magnitudes.

3. DETAILED EVALUATION OF SPRING INITIAL RELEASE PERIOD

The spring initial release period was modeled because it is when the most concentrated pond water will be circulated into South Bay sloughs and creeks. When the initial release begins, the salt ponds will be at their highest salinity and, consequently, any oxygen demand associated with this elevated salinity would be expected to be at a maximum. The experiments performed in this evaluation were based on conditions that are predicted for April because that is when the initial release is planned to begin and, consequently, when the greatest amounts of the highest salinity pond water will be discharged.

Since it is not possible to predict the exact salinity of the ponds at the beginning of the initial release period, in this evaluation, oxygen demand was determined under two sets of “initial salinity” conditions. Six slough and bay segments were evaluated assuming that the salinities of the ponds, at the beginning of the initial release period, were similar to those observed in 2002. In addition, eight slough and bay segments were evaluated assuming that the salinities of the ponds, at the beginning of the initial release period, were at or near their proposed maximum salinities (based on historical data and operational considerations). The two “initial salinity” conditions were incorporated into the study plan in order to (1) evaluate a range of possible initial release conditions and (2) determine the relationship between “initial salinity” and oxygen demand.

Estimation of Segment Composition

The composition of water which would be found in selected slough and bay segments under existing and ISP conditions was estimated for the spring period when the initial circulation would be most likely to be initiated. Estimates were made for each of several slough and bay segments using mathematical modeling techniques. Ten segments were selected for analysis and included two locations in Guadalupe Slough, two locations in Alviso Slough, two locations in Coyote Creek, two locations in South Bay proper adjacent to the Alviso Unit (between the mouths of Guadalupe Slough and Coyote Creek), and two locations in S.F. Bay proper adjacent to the Baumberg Unit (between the mouths of Old Alameda Creek and Alameda Creek Flood Control Channel). The locations and identification codes for these selected segments are summarized in Table 4. For each segment, the types of water and the percentages of each type that are predicted to occur under existing conditions and under ISP conditions are summarized in Tables 5 and 6 (for 2002 salinity conditions and proposed maximum salinity conditions, respectively). As can be seen, under existing conditions, bay and slough segments are predicted to contain mixtures of only two types of water; bay water and upstream slough/creek water. Under ISP conditions, bay and slough segments are predicted to contain mixtures of three or more types of water; bay water, slough water, and pond water(s).

Formulation of Predicted Mixtures

Once the composition of the water in each of the slough and bay segments was predicted for existing and ISP conditions, the next step in our evaluation was to formulate these mixtures. For each segment, this was accomplished by collecting samples from all of the contributing source areas and then mixing them in the proper proportions. The sources of the various samples used in the formulations are also summarized in Tables 5 and 6.

Analysis of Mixtures

Once the predicted existing and ISP mixtures were formulated, they were sent to an analytical laboratory (Pacific EcoRisk in Martinez, California) for ultimate biological oxygen demand (BOD) determinations. These BOD analyses were run according to standard protocol, with the one exception that no nutrients or bacteria were added at the start of the test. Therefore, the results of these analyses indicate how the dissolved oxygen in these mixtures would decrease over time due to the biological activity of the native bacterial and fauna.

For each mixture, the BOD analyses were performed under three sets of diurnal light conditions – i.e., “total dark”, “16 hrs light–8 hrs dark”, and “8 hrs light-16 hrs dark”. This approach was instituted because visual examination of the samples indicated that the mixtures contained relatively high densities of algae. Therefore, if the BOD analyses were performed only in the dark, the results would over-estimate the consumption of oxygen that would occur in the real world. Analyses performed in the dark would only consider the respiration of the algae and not photosynthesis which occurs in nature when the sun is shining.

Oxygen Demand of “2002 Salinity” Mixtures

The results of the ultimate BOD analyses performed on the formulated existing and ISP mixtures for each of the selected slough and bay segments are illustrated in Figure 3. These results indicate that, for all 6 segments evaluated, oxygen demand was higher under ISP conditions when the evaluations were performed in “total dark”. However, when performed under a diurnal light regime of “8 hrs light-16 hrs dark”, the higher oxygen demand under circulation conditions decreased for all 6 segments tested: 5 out of the 6 segments actually showed a net increase in DO (i.e., oxygen generated rather than consumed). When the diurnal cycle was switched to “16 hrs light-8 hrs dark”, the decrease in oxygen demand under circulation conditions was even greater: all 6 of the segments showed a net increase in DO.

Oxygen Demand of “Proposed Maximum Salinity” Mixtures

The results of the ultimate BOD analyses performed on the formulated existing and ISP mixtures for each of the selected slough and bay segments are illustrated in Figure 4. These results indicate that, for all 8 segments evaluated, oxygen demand was higher under ISP conditions when the evaluations were performed in “total dark”. However, when performed under a diurnal light regime of “8 hrs light-16 hrs dark”, the higher oxygen demand under circulation conditions decreased for all 8 segments tested: 6 out of the 8 segments actually showed a net increase in DO (i.e., oxygen generated rather than consumed). When the diurnal cycle was switched to “16 hrs light-8 hrs dark", the decrease in oxygen demand under circulation conditions was even greater: all 8 of the segments showed a net increase in DO.

Significance of Altered Oxygen Demand

For all 14 of the segments evaluated (6 starting at 2002 salinity conditions and 8 starting at proposed maximum salinity conditions) , the results indicate that under realistic lighting conditions, oxygen sags are not expected to occur during the spring initial release period. When analyzed in "total darkness", the addition of saline pond water resulted in increased oxygen demand and would lead to non-compliance with the Basin Plan's water quality objective of 5 mg/l for dissolved oxygen in 13 of the 14 segments evaluated. This is illustrated in Table 7 and Figure 5 by comparing the estimated "time to reach 5 mg/l DO" with the "estimated residence time" in each segment. In all cases, except for a segment of Artesian Slough (CC-9), the "time to reach 5 mg/l" is less than the "estimated residence time". However, when the conditions are made more realistic by introducing a diurnal light regime, the situation changes dramatically and the 5 mg/l Basin Plan limit is not threatened. This is illustrated in Table 8 and Figure 6 for the "8 hr light–16 hr dark" cycle and in Table 9 and Figure 7 for the "16 hr light–8 hr dark" cycle. Under both light regimes, the "time to reach 5 mg/l DO" is much greater than the "estimated residence time" for all segments evaluated, regardless of the initial salinity of the discharging ponds. These results indicate that the oxygen demand measured in the dark was primarily due to the respiration of algae and, with even a short daily period of light, the production of oxygen via photosynthesis would surpass the consumption of oxygen via respiration; resulting in a net gain in dissolved oxygen.

4. APPLICABILITY OF RESULTS TO CURRENT OPERATION PLAN

As pointed out earlier in this document, the mixtures that were formulated and analyzed for oxygen consumption in this study are not perfectly representative of the mixtures that are now expected during the currently configured ISP operations plan. This discrepancy occurred because the plans for circulating pond water have changed since these experiments were designed and performed. Consequently, the mixtures that are now predicted for the ISP are somewhat different from the analyzed mixtures. However, in spite of these differences, the experimental results are deemed adequate for addressing the current operation plan because (1) the formulated mixtures and currently predicted ISP mixtures are fairly similar and (2) a sensitivity analysis indicates that changes in the type and amount of saline pond water do not significantly alter the consumption of dissolved oxygen.

Comparison of Formulated Mixtures and Currently Predicted Mixtures – In Figure 8, for each of 13 bay and slough segments, a comparison is made between the composition of the mixtures that were tested in early Fall 2001 and the composition of the mixtures that are predicted to occur under the current ISP for the early fall discharge period. (A comparison is not presented for segment OAC-3 in Old Alameda Creek because of the lack of quantitative modeling results for this waterbody). There is a separate graph for each segment and each graph presents two source distributions. The distribution represented by the light colored, striped bars is for those conditions that were predicted under the operation plan in effect in early Fall 2001 and for which samples were formulated and analyzed for oxygen consumption. The distribution represented by the dark colored, solid bars is for the conditions that are predicted to occur under the current ISP operation plan. In general, it can be seen that the two distributions in each graph are quite similar for most of the segments and, therefore, the predicted oxygen consumption would be expected to be similar also. For several of the segments (i.e., bay segments near Alviso, bay segments near Baumberg, and two Alameda Flood Control Channel segments), it appears that the mixtures tested in October 2001 contained a greater amount of higher salinity water than predicted under the current operation plan. This would suggest that, for these segments, the oxygen consumption values generated in this study (using the early Fall 2001 samples) are likely to be conservative (i.e., over-estimates) when applied to the currently predicted mixtures.

Figure 9 presents a similar set of comparisons for the spring initial release period for those samples formulated based on pond salinities observed in 2002. For this period, the similarities are even more striking between source distributions in the samples that were formulated and analyzed and source distributions predicted under the current ISP operation plan. For all 6 segments evaluated, it appears that the mixtures formulated and tested in Spring 2002 contained a greater amount of higher salinity water than the currently predicted mixtures. This would suggest that the oxygen consumption values generated in this study, under 2002 "initial salinity" conditions, are likely to be conservative (i.e., over-estimates) when applied to the currently predicted ISP mixtures.

Figure 10 presents a similar set of comparisons for the spring initial release period for those samples formulated based on proposed maximum pond salinities. For this period, the similarities are equally striking between source distributions in the samples that were formulated and analyzed and source distributions predicted under the current ISP operation plan. For all 8 segments evaluated, it appears that the mixtures formulated and tested in Spring 2002 contained a greater amount of higher salinity water than the currently predicted mixtures. This would suggest that the oxygen consumption values generated in this study, under "proposed maximum salinity" conditions, are likely to be conservative (i.e., over-estimates) when applied to the currently predicted ISP mixtures.

Sensitivity Analysis for Changes in Discharge Salinity – As part of the testing program performed in Spring 2002, experiments were performed to determine how changes in the salinity of discharged pond water would affect the dissolved oxygen in the receiving waters. The tests consisted of preparing two different mixtures for BOD analysis for each of four segments (i.e., Alviso Slough Segment 1, Alviso Slough Segment 3, South Bay at Alviso Near Field, and South Bay at Alviso Far Field). In each segment, the pair of mixtures that were formulated differed from one another only in the salinity of the contributing pond water (i.e., from A9). The two salinities evaluated were 48 ppt and 86 ppt. The results of the evaluations performed in these paired experiments are illustrated in Figures 11a -d. For all four segments, the results indicate that, under realistic diurnal light conditions, there is no apparent difference in oxygen demand produced when the salinity of the discharging pond changes from 48 ppt to 86 ppt. There is a difference when the analyses were performed in the dark (apparently due to respiration of algae), but this difference disappears when normal light regimes are employed. The results of these paired experiments indicate that, during the spring initial release period, differences in the salinity of the discharged pond water does not cause significant changes in oxygen consumption.

Consequently, even though there are some differences in salinity profiles, the conclusions reached based on the mixtures formulated and analyzed in this study should also apply fairly well to the mixtures predicted to occur during the current ISP operation plan.

Sensitivity Analysis for Changes in Discharge Volume – Another part of the Spring 2002 testing program was a set of experiments designed to determine how changes in the amount of saline pond water being discharged would affect the dissolved oxygen in the receiving waters. In the experiments, two different mixtures were prepared for each of the two Alviso Slough segments. These mixtures were identical except for the amount of saline pond water that was added; with one mixture receiving twice as much as the other. (The salinity of the pond water added to both mixtures was the same.) The results of the evaluations are illustrated in Figures 12a-b and indicate that, under realistic diurnal light conditions, there is no apparent difference in oxygen demand between the two treatments. There was a small difference in the dark (apparently due to respiration of algae), but even this difference disappeared when a daily period of light was included (either 8 or 16 hrs). The results of these paired experiments indicate that, during the spring initial release period, differences in the amount of saline pond water discharged does not cause significant changes in oxygen consumption. Consequently, even though there are differences in the amount of saline pond water present, the conclusions reached based on the formulated mixtures should also apply fairly well to the mixtures predicted to occur under the current ISP operation plan.

5. LITERATURE CITED

Kinnetic Laboratories, Inc. 1987. South Bay Dischargers Authority Water Quality Monitoring Program: Final Monitoring Report, December 1981 – November 1986. Prepared for South Bay Dischargers Authority, San Jose, CA.

Table 1. Bay and Slough Segments Modeled, Formulated, and Analyzed
"Late Summer-Early Fall" Discharge Period

Segment Modeled for Formulation	Segment Description
For Alviso Unit:	
Guadalupe Slough 3 (GS-3)	In slough, 4-5 km upstream of bay: vicinity of SBDA monitoring station C-1-3
Guadalupe Slough 4 (GS-4)	In slough, 2-3 km upstream of bay; vicinity of SBDA monitoring station C-4-4
Alviso Slough 2 (AS-2)	In slough, 1-2 km upstream of bay
Alviso Slough 4 (AS-4)	In slough, 3-4 km upstream of bay
Alviso Slough 6 (AS-6)	In slough, 5-6 km upstream of bay
Coyote Creek 1 (CC-1)	In creek, upstream of mouth to Alviso Slough to mouth of Mud Slough
Coyote Creek 2 (CC-2)	In creek, upstream of Mud Slough to beyond Pond A18
So Bay @ Alviso Near (SBN)	A rectangular area (~2.2x3.2 km) encompassing the lower quarter of South Bay
So Bay @ Alviso Far (SBF)	A larger rectangular area (~4x4.2 km) encompassing the lower half of South Bay
For Baumberg Unit:	
Old Alameda Creek 3 (OAC-3)	In creek, in vicinity of Pond 8A discharge
Alameda Fl'd Cont'l 3 (AFC-3)	In channel, 3-4 km upstream of bay
Alameda Fl'd Cont'l 4 (AFC-4)	In channel, 4-5 km upstream of bay
Bay @ Baumberg Near (BBN)	A rectangular area (~1.4x6.8 km) encompassing Bay just offshore of Old Alameda Creek and Alameda Flood Control Channel
Bay @ Baumberg Far (BBF)	A larger rectangular area (~2.2x11.8 km) in Bay offshore of the Baumberg Unit extending equally in all directions from BBN

Table 2. Characterization of Samples Formulated and Analyzed for Ultimate BOD: "Late Summer-Early Fall" Discharge Period

Model Segment (I.D. Code)	Contributing Sources	Point of Collection	Formulated % Composition Existing	Formulated % Composition ISP
Guadalupe Slough - 3	Bay Water - South of Dumbarton Bridge	In bay, 0.5 mi N of Guad Sl @ 27.5 ppt	48	20.0
GS-3	Upstream in Guadalupe Slough	< Sunnyvale discharge @ 2 ppt)	52	12.0
	31-33 ppt Pond Water from A5 & A3W	Pond A9 @ 32 ppt		68.0
Guadalupe Sl - 4	Bay Water - South of Dumbarton Bridge	In bay, 0.5 mi N of Guad Sl @ 27.5 ppt	61	29.0
GS-4	Upstream in Guadalupe Slough	< Sunnyvale discharge @ 2 ppt)	39	60.0
	31-33 ppt Pond Water from A5 & A3W	Pond A9 @ 32 ppt		11.0
Alviso Slough - 2	Bay Water - South of Dumbarton Bridge	In bay, 0.5 mi N of Guad Sl @ 27.5 ppt	72	39.2
AS-2	Upstream in Guadalupe River	Upstream in Guadalupe River @ 2ppt	28	26.5
	24 ppt Pond Water from Ponds A9 & A12	Pond B1 @ 23.5 ppt		24.1
	31-33 ppt Pond Water from Ponds A10 & A11	Pond A9 @ 32 ppt		10.1
Alviso Slough - 4	Bay Water - South of Dumbarton Bridge	In bay, 0.5 mi N of Guad Sl @ 27.5 ppt	38	1.0
AS-4	Upstream in Guadalupe River	Upstream in Guadalupe River @ 2ppt	62	45.8
	24 ppt Pond Water from Ponds A9 & A12	Pond B1 @ 23.5 ppt		41.2
	31-33 ppt Pond Water from Ponds A10 & A11	Pond A9 @ 32 ppt		12.0
Alviso Slough - 6	Bay Water - South of Dumbarton Bridge	In bay, 0.5 mi N of Guad Sl @ 27.5 ppt	5	0.0
AS-6	Upstream in Guadalupe River	Upstream in Guadalupe River @ 2ppt	95	55.2
	24 ppt Pond Water from Ponds A9 & A12	Pond B1 @ 23.5 ppt		44.3
	31-33 ppt Pond Water from Ponds A10 & A11	Pond A9 @ 32 ppt		0.6
Coyote Creek- 1	Bay Water - South of Dumbarton Bridge	In bay, 0.5 mi N of Guad Sl @ 27.5 ppt	80	54.6
CC-1	Upstream in Artesian Slough	In Artesian Slough @ 0.8 ppt	20	31.2
	24 ppt Pond Water from Ponds A16, A9 & A12	Pond B1 @ 23.5 ppt		4.8
	31-33 ppt Pond Water from Ponds A10 & A11	Pond A9 @ 32 ppt		9.5
Coyote Creek - 2	Bay Water - South of Dumbarton Bridge	In bay, 0.5 mi N of Guad Sl @ 27.5 ppt	48.6	30.0
CC-2	Upstream in Artesian Slough	In Artesian Slough @ 0.8 ppt	51.4	59.0
	24 ppt Pond Water from Ponds A16, A9 & A12	Pond B1 @ 23.5 ppt		4.6
	31-33 ppt Pond Water from Ponds A10 & A11	Pond A9 @ 32 ppt		6.5

Table 2 Cont'd. Characterization of Samples Formulated and Analyzed for Ultimate BOD: "Late Summer-Early Fall" Discharge Period

Model Segment (I.D. Code)	Contributing Sources	Point of Collection	Formulated % Composition Existing	ISP
South Bay @ Alviso	Bay Water - South of Dumbarton Bridge	In bay, 0.5 mi N of Guad Sl @ 27.5 ppt	100	83.0
Near (SBN)	24 ppt Pond Water from Ponds A9 & A12	Pond B1 @ 23.5 ppt		4.0
	31-33 ppt Pond Water from A3W, A5, A10 & A11	Pond A9 @ 32 ppt		13.0
South Bay @ Alviso	Bay Water - South of Dumbarton Bridge	In bay, 0.5 mi N of Guad Sl @ 27.5 ppt	100	85.5
Far (SBF)	24 ppt Pond Water from Ponds A9 & A12	Pond B1 @ 23.5 ppt		3.5
	31-33 ppt Pond Water from A3W, A5, A10 & A11	Pond A9 @ 32 ppt		11.0
Old Alameda Creek	Bay Water - Near Baumberg Unit	In bay, 0.5 mi W of AFCC @ 30.5 ppt	100	16.5
OAC-3	Upstream in Old Alameda Creek	0.5 mi upstream of dam @ 1.3 ppt		9.3
	34-35 ppt Pond Water from Pond 8A	Pond 1 @ 33.5 ppt		74.2
Alameda Flood Cont	Bay Water - Near Baumberg Unit	In bay, 0.5 mi W of AFCC @ 30.5 ppt	52.3	32.9
AFCC-3	Upstream in Alameda Flood Control Channel	In AFCC, 1 mi > salt ponds @ 1 ppt	47.7	33.9
	34-35 ppt Pond Water from Pond 2C	Pond 1 @ 33.5 ppt		33.2
Alameda Flood Cont	Bay Water - Near Baumberg Unit	In bay, 0.5 mi W of AFCC @ 30.5 ppt	32.3	15.5
AFCC-4	Upstream in Alameda Flood Control Channel	In AFCC, 1 mi > salt ponds @ 1 ppt	67.7	54.5
	34-35 ppt Pond Water from Pond 2C	Pond 1 @ 33.5 ppt		29.9
So Bay @ Baumberg	Bay Water - Near Baumberg Unit	In bay, 0.5 mi W of AFCC @ 30.5 ppt	100	76.6
Near (BBN)	24 ppt Pond Water from Ponds A9, A12 & A16	Pond B1 @ 23.5 ppt		1.4
	34-35 ppt Pond Water from Pond 2, 2C, 8A, 10	Pond 1 @ 33.5 ppt		22.0
So Bay @ Baumberg	Bay Water - Near Baumberg Unit	In bay, 0.5 mi W of AFCC @ 30.5 ppt	100	87.2
Far (BBF)	24 ppt Pond Water from Ponds A9, A12 & A16	Pond B1 @ 23.5 ppt		1.4
	34-35 ppt Pond Water from Pond 2, 2C, 8A, 10	Pond 1 @ 33.5 ppt		11.5

Table 3. Comparison of Estimated "Time to Reach 5 mg/l DO" with Predicted Residence Time during "Late Summer-Early Fall" Discharge Period

Segment	Estimated Time to Reach 5 mg/l D.O. (days)		Estimated Residence Time (days)
	Existing	ISP	
Guadalupe Slough			
GS-3	9	16	3.0
GS-4	12	13	2.1
Alviso Slough			
AS-2	50	25	1.2
AS-4	45	15	3.6
AS-6	18	16	5.6
Coyote Creek			
CC-1	47	29	2.5
CC-2	29	19	3.2
So Bay @ Alviso			
Near (SBN)	>60	48	2.4
Far (SBF)	>60	49	5.2
Old Alameda Creek			
OAC-3	>60	15	7.7
Alameda Flood Control			
AFCC-3	>60	31	1.3
AFCC-4	46	31	1.6
Bay @ Baumberg			
Near (BBN)	>60	>60	3.3
Far (BBF)	>60	>60	6.8

Figure 2. Comparison "Time to 5 mg/l DO" under Circulation Conditions with Predicted Residence Time

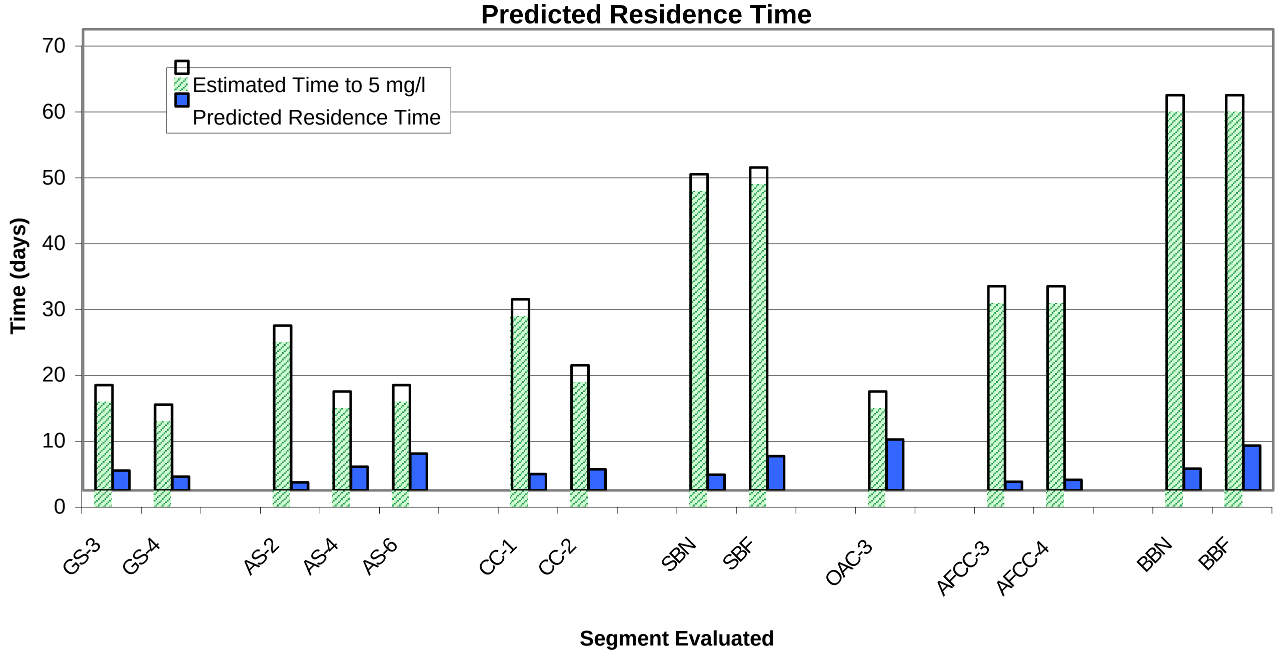


Figure 1. Measured Oxygen Consumption in Bay and Slough Segments under Existing and Initial Stewardship Period (ISP) Conditions for "Late Summer-Early Fall" Discharge Period

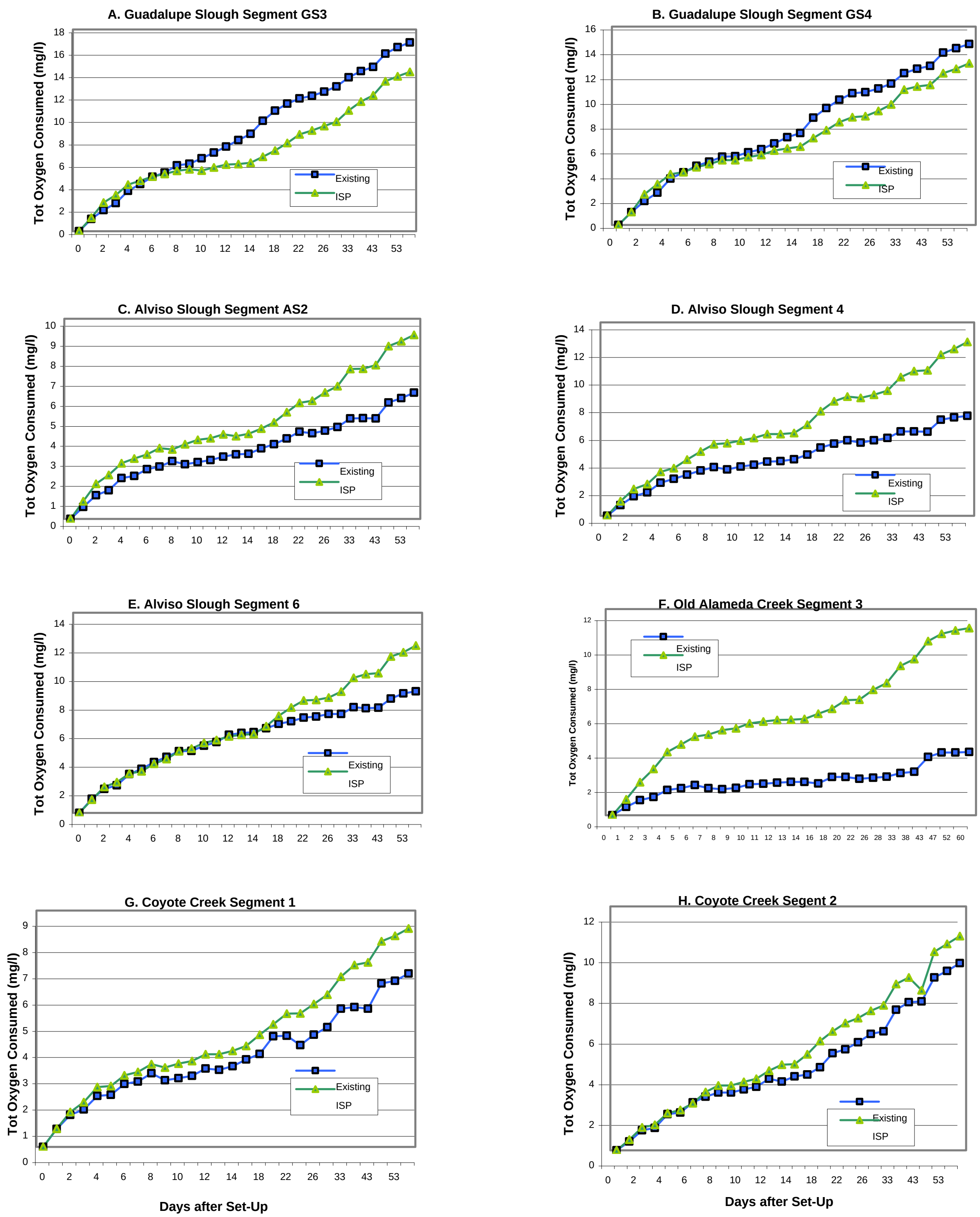
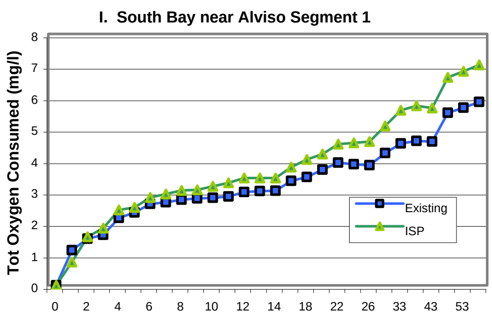
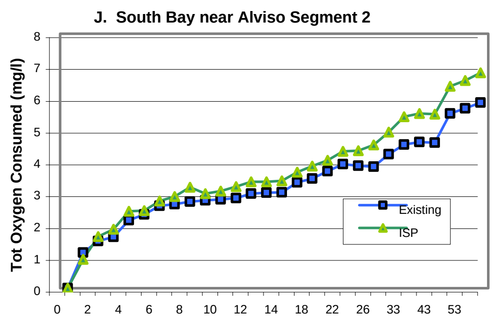
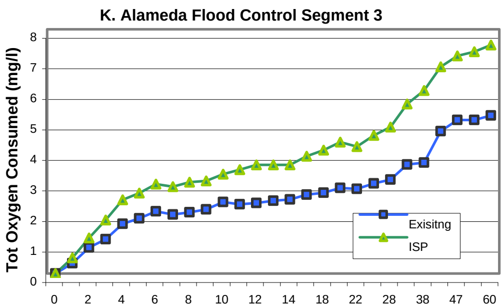
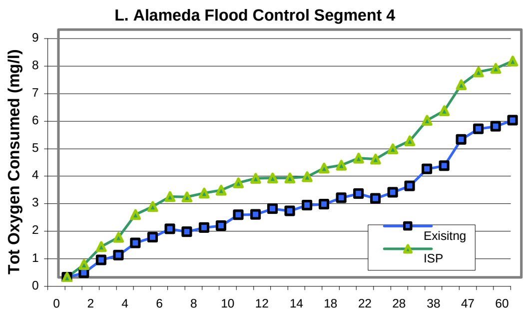


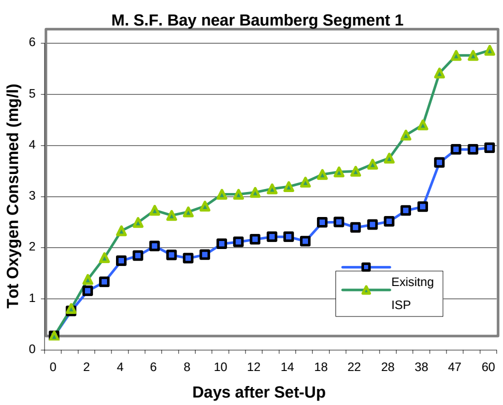
Figure 1 Cont'd. Measured Oxygen Consumption in Bay and Slough Segments under Existing and Initial Stewardship Period (ISP) Conditions for "Late Summer-Early Fall" Discharge Period











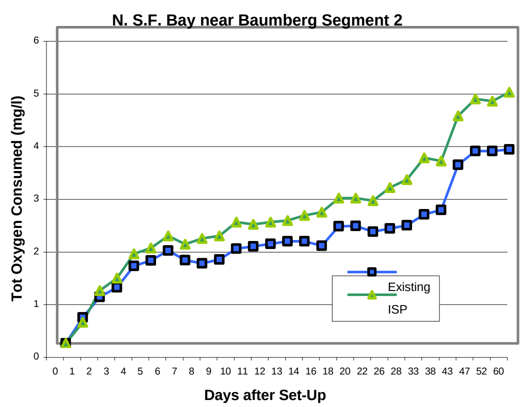


Table 4. Bay and Slough Segments Modeled, Formulated, and Analyzed
Spring Initial Release Period

Segment Modeled for Formulation	Segment Description
For Alviso Unit:	
Guadalupe Slough 2 (GS-2)	In slough, 1-2 km upstream of bay
Guadalupe Slough 4 (GS-4)	In slough, 3-4 km upstream of bay
Alviso Slough 1 (AS-1)	In slough, 0-1 km upstream of bay
Alviso Slough 3 (AS-3)	In slough, 2-3 km upstream of bay
Coyote Creek 3 (CC-3)	In creek, 2-3 km upstream of bay
Coyote Creek 9 (CC-9)	In creek, 8-9 km upstream of bay
So Bay @ Alviso Near (SBN)	A rectangular area (~2.2x3.2 km) encompassing the lower quarter of South Bay
So Bay @ Alviso Far (SBF)	A larger rectangular area (~4x4.2 km) encompassing the lower half of South Bay
For Baumberg Unit:	
Bay @ Baumberg Near (BBN)	A rectangular area (~1.4x6.8 km) encompassing Bay just offshore of Old Alameda Creek and Alameda Flood Control Channel
Bay @ Baumberg Far (BBF)	A larger rectangular area (~2.2x11.8 km) in Bay offshore of the Baumberg Unit extending equally in all directions from BBN

Table 5. Characterization of Samples Formulated and Analyzed for Spring Initial Release Period (formulations based on pond discharges commencing at salinity values observed in 2002)

Model Segment (I.D. Code)	Contributing Sources	Point of Collection	Formulated % Composition Baseline	Circulation
Guadalupe Slough - 2	Bay Water - South of Dumbarton Bridge	In bay, 0.5 mi N of Guad Sl @ 20 ppt	68.6	20.0
GS-2	Upstream in Guadalupe Slough	< Sunnyvale discharge @ 3 ppt)	31.4	15.9
	26-30 ppt Pond Water from A5 & A3W	Pond A3N @ 27 ppt		64.1
Guadalupe Sl - 4	Bay Water - South of Dumbarton Bridge	In bay, 0.5 mi N of Guad Sl @ 20 ppt	46.2	1.4
GS-4	Upstream in Guadalupe Slough	< Sunnyvale discharge @ 3 ppt)	53.8	26.2
	26-30 ppt Pond Water from Ponds A5 & A3W	Pond A3N @ 27 ppt		72.4
Alviso Slough - 1	Bay Water - South of Dumbarton Bridge	In bay, 0.5 mi N of Guad Sl @ 20 ppt	70.9	60.1
AS-1	Upstream in Guadalupe River	Upstream in Guadalupe River	29.1	22.7
	48 ppt Pond Water from Pond A9	Pond A5 @ 50 ppt		17.2
Alviso Slough - 1	Bay Water - South of Dumbarton Bridge	In bay, 0.5 mi N of Guad Sl @ 20 ppt	70.9	64.4
AS-1	Upstream in Guadalupe River	Upstream in Guadalupe River	29.1	27.0
(sensitivity analysis)	48 ppt Pond Water from Pond A9 (50% Volume)	Pond A5 @ 50 ppt		8.6
Alviso Slough - 3	Bay Water - South of Dumbarton Bridge	In bay, 0.5 mi N of Guad Sl @ 20 ppt	38.5	22.2
AS-3	Upstream in Guadalupe River	Upstream in Guadalupe River	61.5	57.5
	48 ppt Pond Water from Pond A9	Pond A5 @ 50 ppt		20.3
Alviso Slough - 3	Bay Water - South of Dumbarton Bridge	In bay, 0.5 mi N of Guad Sl @ 20 ppt	38.5	27.3
AS-3	Upstream in Guadalupe River	Upstream in Guadalupe River	61.5	62.5
(sensitivity analysis)	48 ppt Pond Water from Pond A9 (50% Volume)	Pond A5 @ 50 ppt		10.2
South Bay @ Alviso	Bay Water - South of Dumbarton Bridge	In bay, 0.5 mi N of Guad Sl @ 20 ppt	100	85.5
Near (SBN)	26-30 ppt Pond Water from Ponds A5 & A3W	Pond A3N @ 27 ppt		8.7
	36-41 ppt Pond Water from Pond A16	Pond A4 @ 40 ppt		0.7
	49-53 ppt Pond Water from Pond A9	Pond A5 @ 50 ppt		5.1
South Bay @ Alviso	Bay Water - South of Dumbarton Bridge	In bay, 0.5 mi N of Guad Sl @ 20 ppt	100	87.9
Far (SBF)	26-30 ppt Pond Water from Ponds A5 & A3W	Pond A3N @ 27 ppt		7.2
	36-41 ppt Pond Water from Pond A16	Pond A4 @ 40 ppt		0.6
	49-53 ppt Pond Water from Pond A9	Pond A5 @ 50 ppt		4.3

Table 6. Characterization of Samples Formulated and Analyzed for Spring Initial Release Period (formulations based on pond discharges commencing at or near proposed maximum salinity values)

Model Segment (I.D. Code)	Contributing Sources	Point of Collection	Formulated % Composition Baseline	Formulated % Composition Circulation
Coyote Creek- 3	Bay Water - South of Dumbarton Bridge	In bay, 0.5 mi N of Guad Sl @ 20 ppt	76.2	69.5
CC-3	Upstream in Artesian Slough	In Artesian Slough @ 0.5 ppt	23.8	21.8
	26-30 ppt Pond Water from Ponds A5 & A3W	Pond A3N @ 27 ppt		0.2
	86 ppt Pond Water from Pond A9	Pond A8 @ 87 ppt		7.4
	144 ppt Pond Water from A16	Pond A19 @ 155 ppt		1.1
Coyote Creek - 9	Bay Water - South of Dumbarton Bridge	In bay, 0.5 mi N of Guad Sl @ 20 ppt	2.2	1.4
CC-9	Upstream in Artesian Slough	In Artesian Slough @ 0.5 ppt	97.8	92.8
	26-30 ppt Pond Water from Ponds A5 & A3W	Pond A8 @ 87 ppt		0.0
	86 ppt Pond Water from Pond A9	Pond A8 @ 87 ppt		7.4
	144 ppt Pond Water from A16	Pond A19 @ 155 ppt		5.4
Alviso Slough - 1	Bay Water - South of Dumbarton Bridge	In bay, 0.5 mi N of Guad Sl @ 20 ppt	70.9	60.1
AS-1	Upstream in Guadalupe River	Upstream in Guadalupe River	29.1	22.7
	86 ppt Pond Water from Pond A9	Pond A8 @ 87 ppt		17.2
Alviso Slough - 3	Bay Water - South of Dumbarton Bridge	In bay, 0.5 mi N of Guad Sl @ 20 ppt	38.5	22.2
AS-3	Upstream in Guadalupe River	Upstream in Guadalupe River	61.5	57.5
	86 ppt Pond Water from Pond A9	Pond A8 @ 87 ppt		20.3
South Bay @ Alviso	Bay Water - South of Dumbarton Bridge	In bay, 0.5 mi N of Guad Sl @ 20 ppt	100	85.5
Near (SBN)	26-30 ppt Pond Water from Ponds A5 & A3W	Pond A3N @ 27 ppt		8.7
	36-41 ppt Pond Water from Pond A16	Pond A4 @ 40 ppt		0.7
	86 ppt Pond Water from Pond A9	Pond A8 @ 87 ppt		5.1
South Bay @ Alviso	Bay Water - South of Dumbarton Bridge	In bay, 0.5 mi N of Guad Sl @ 20 ppt	100	87.9
Far (SBF)	26-30 ppt Pond Water from Ponds A5 & A3W	Pond A3N @ 27 ppt		7.2
	36-41 ppt Pond Water from Pond A16	Pond A4 @ 40 ppt		0.6
	86 ppt Pond Water from Pond A9	Pond A8 @ 87 ppt		4.3

Table 6 Cont'd. Characterization of Samples Formulated and Analyzed for Spring Initial Release Period (formulations based on pond discharges commencing at or near proposed maximum salinity values)

Model Segment (I.D. Code)	Contributing Sources	Point of Collection	Formulated % Composition Baseline	Circulation
So Bay @ Baumberg	Bay Water - Near Baumberg Unit	In bay, 0.5 mi N of Guad Sl @ 20 ppt	100	76.8
Near (BBN)	26-30 ppt Pond Water from A5, A2W & A3W	Pond A3N @ 27 ppt		1.4
	30-33 ppt Pond Water From Ponds 2 & 2C	Pond A2 @ 34 ppt		15.2
	86 ppt Pond Water from Pond A9	Pond A8 @ 87 ppt		0.9
	144-150 ppt Pond Water from Ponds 8A & A16	Pond A19 @ 155 ppt		5.7
So Bay @ Baumberg	Bay Water - Near Baumberg Unit	In bay, 0.5 mi N of Guad Sl @ 20 ppt	100	88.2
Far (BBF)	26-30 ppt Pond Water from A5, A2W & A3W	Pond A3N @ 27 ppt		1.3
	30-33 ppt Pond Water From Ponds 2 & 2C	Pond A2 @ 34 ppt		7.1
	86 ppt Pond Water from Pond A9	Pond A8 @ 87 ppt		0.8
	144-150 ppt Pond Water from Ponds 8A & A16	Pond A19 @ 155 ppt		2.6

Figure 3. Measured Oxygen Consumption in Bay and Slough Segments under Existing and Initial Stewardship Period (ISP) Conditions for Spring of First Year (i.e., Initial Release Period) - <u>2002 Salinity Values</u>

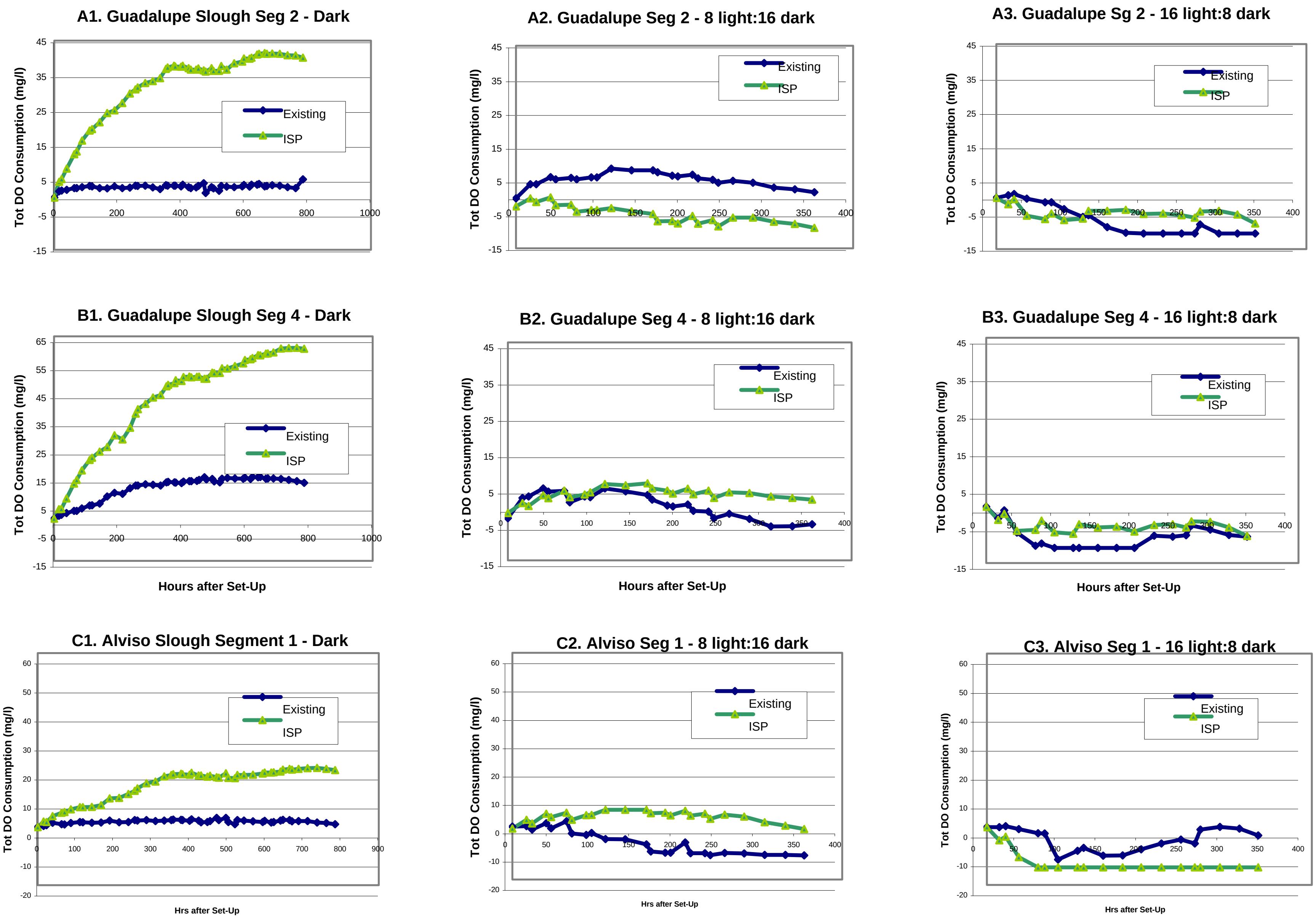
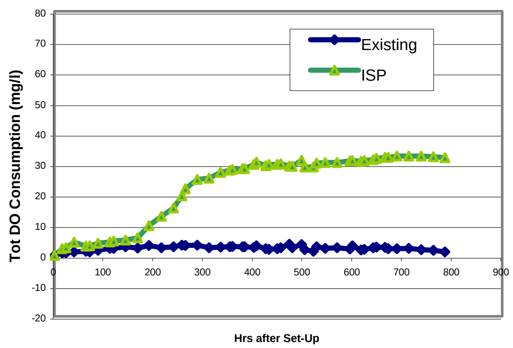
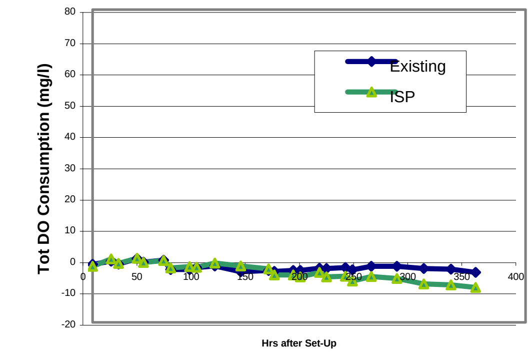


Figure 3 Cont'd. Measured Oxygen Consumption in Bay and Slough Segments under Existing and Initial Stewardship Period (ISP) Conditions for Spring of First Year (i.e., Initial Release Period) - <u>2002 Salinity Values</u>

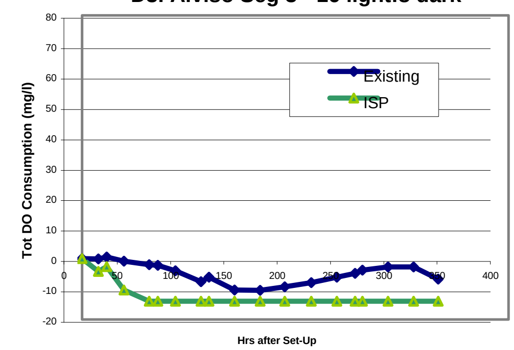
D1. Alviso Slough Segment 3 - Dark



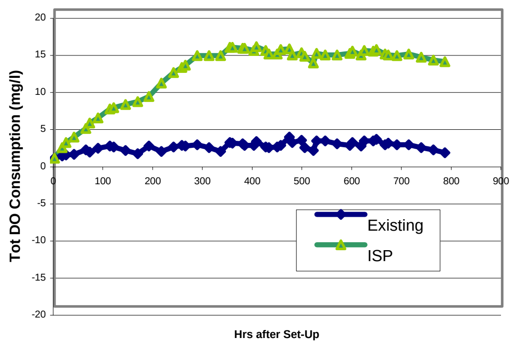
D2. Alviso Seg 3 - 8 light:16 dark



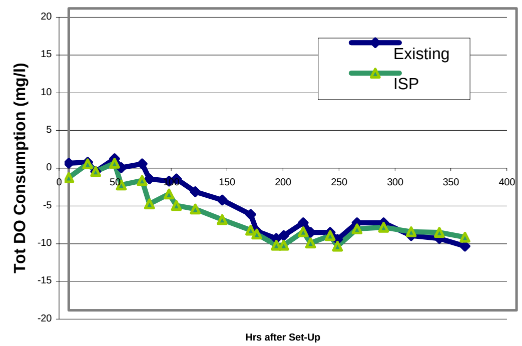
D3. Alviso Seg 3 - 16 light:8 dark



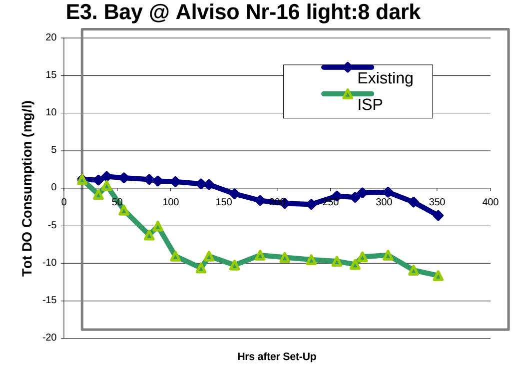
E1. So Bay @ Alviso Near - Dark



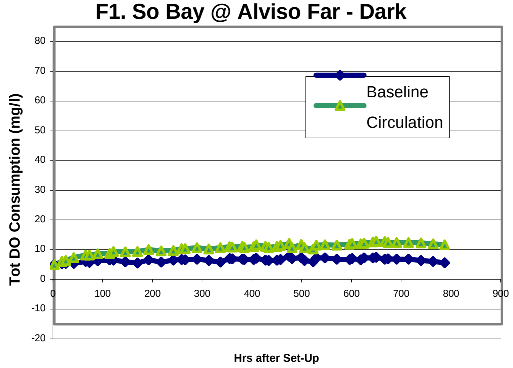
E2. Bay @ Alviso Nr- 8 light:16 dark



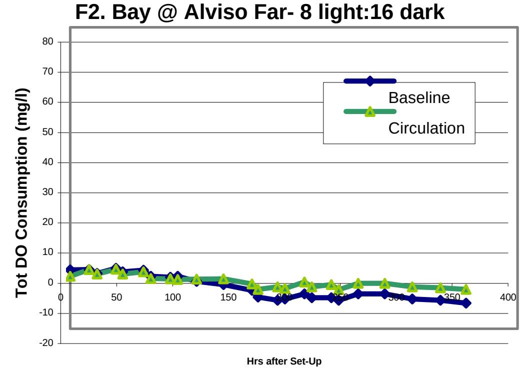
E3. Bay @ Alviso Nr-16 light:8 dark



F1. So Bay @ Alviso Far - Dark



F2. Bay @ Alviso Far- 8 light:16 dark



F3. Bay @ Alviso Far-16 light:8 dark

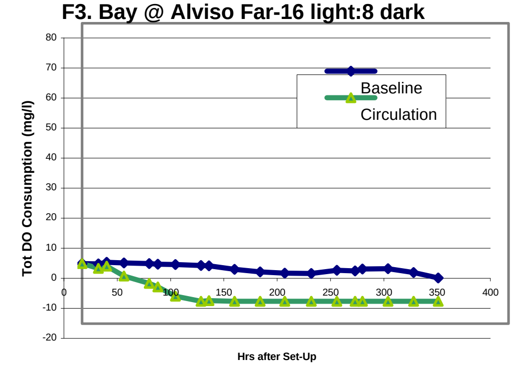


Figure 4. Measured Oxygen Consumption in Bay and Slough Segments under Existing and Initial Stewardship Period (ISP) Conditions for Spring of First Year (i.e., Initial Release Period) - Proposed Maximum Salinity Values

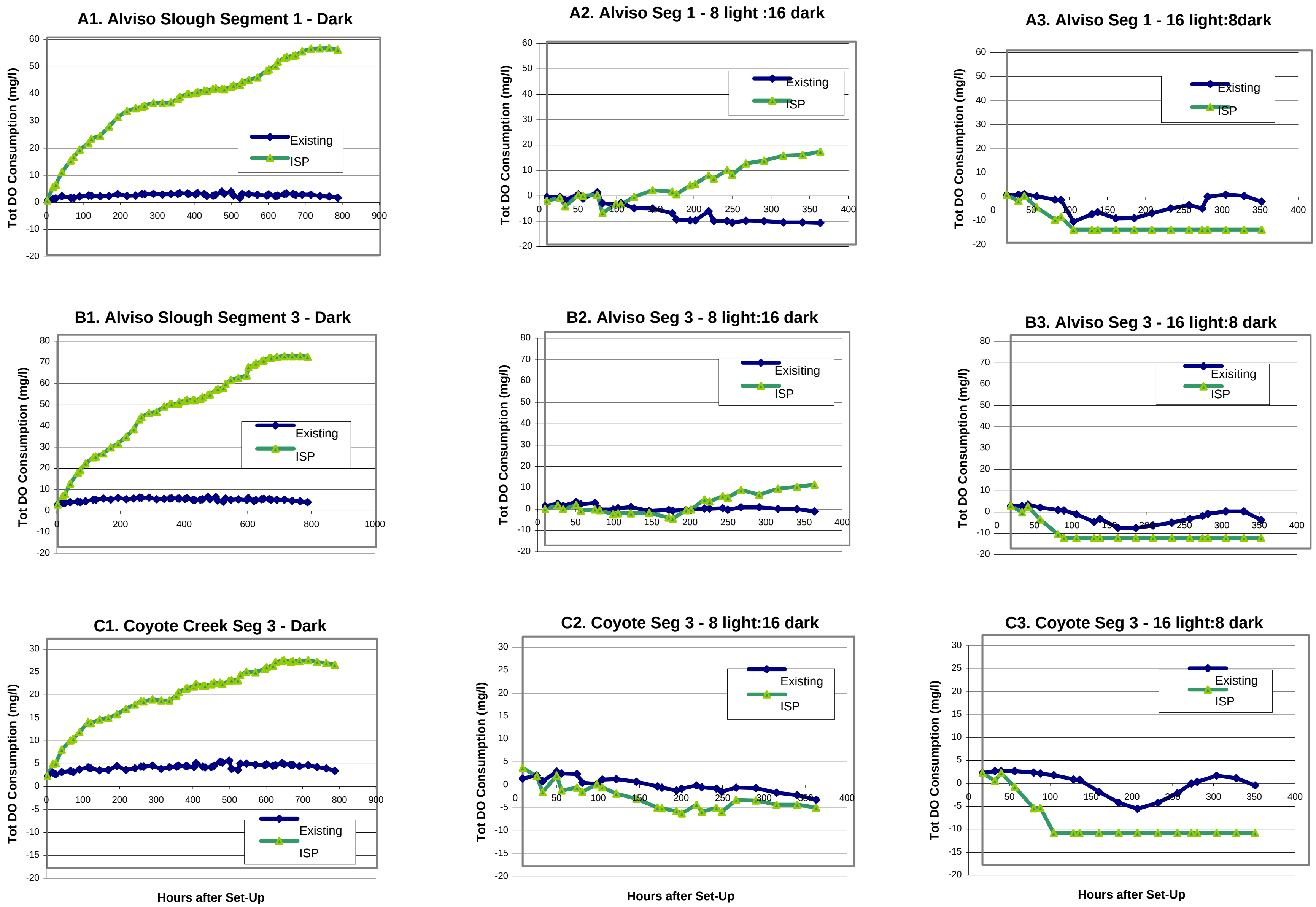


Figure 4 Cont'd. Measured Oxygen Consumption in Bay and Slough Segments under Existing and Initial Stewardship Period (ISP) Conditions for Spring of First Year (i.e., Initial Release Period) - <u>Proposed Maximum Salinity Values</u>

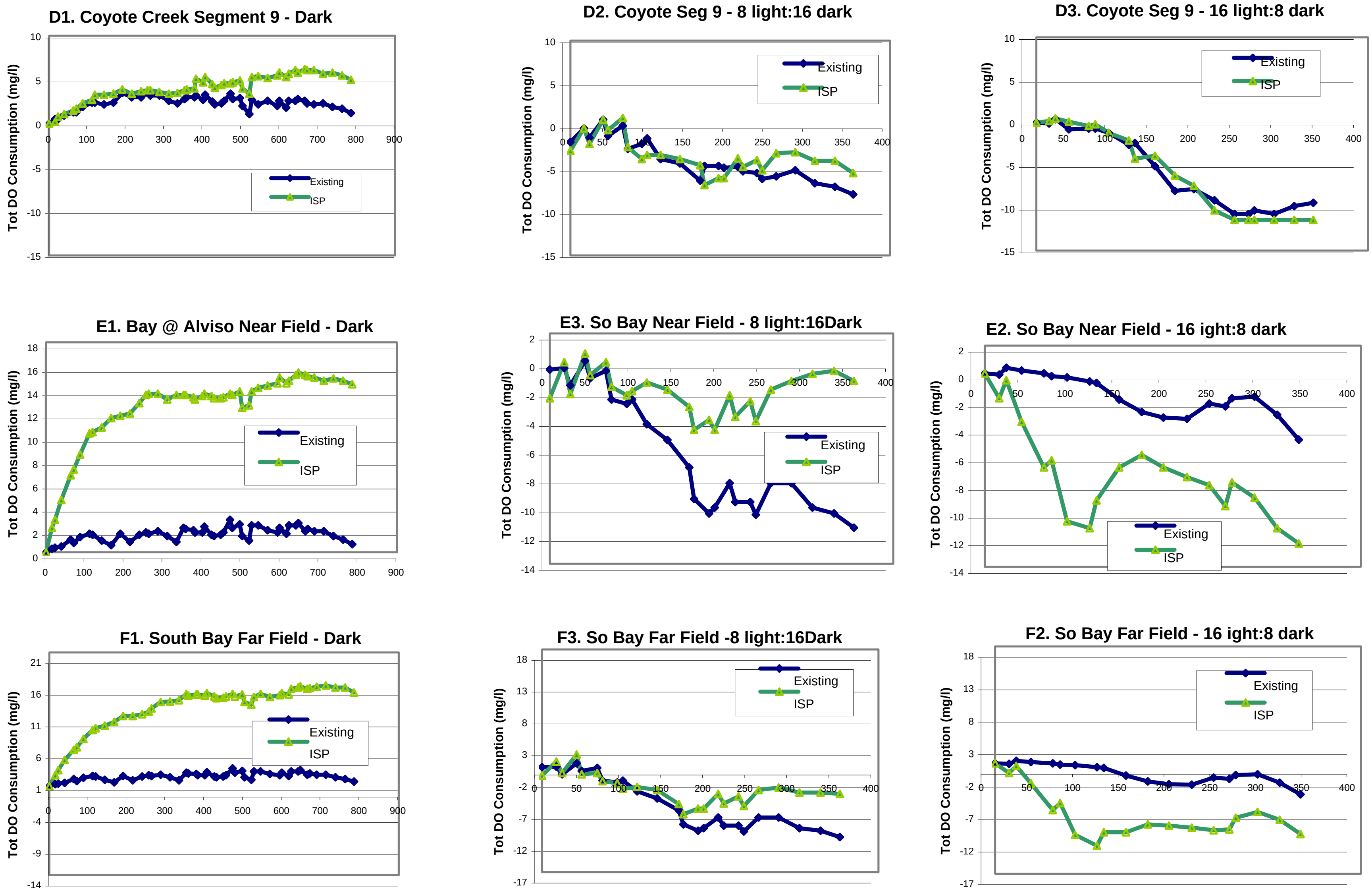


Figure 4 Cont'd. Measured Oxygen Consumption in Bay and Slough Segments under Existing and Initial Stewardship Period (ISP) Conditions for Spring of First Year (i.e., Initial Release Period) - Proposed Maximum Salinity Values

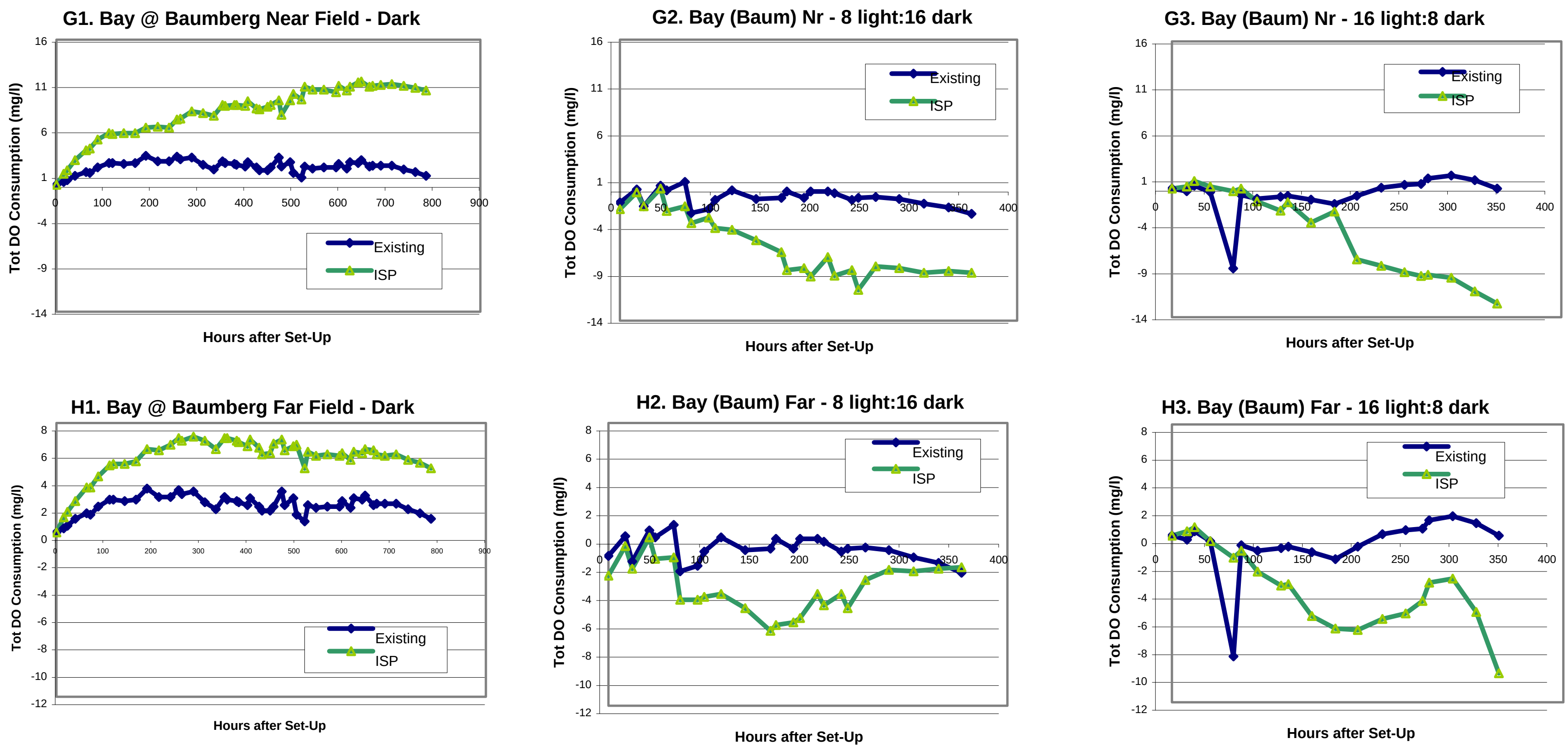


Table 7. Comparison of Estimated "Time to Reach 5 mg/l DO" with Predicted Residence Time during Spring Initial Release Period - in 100% Dark

Segment	Estimated Time to Reach 5 mg/l D.O. (days)		Estimated Residence Time (days)
	Existing	ISP	
Guadalupe Slough			
GS-2 (2002 salinity)	32	<1	2.1
GS-4 (2002 salinity)	5	<1	3.0
Alviso Slough			
AS-1 (2002 salinity)	>33	<1	1.2
AS-1 (max salinity)	>33	<1	1.2
AS-3 (2002 salinity)	>33	<1	3.6
AS-3 (max salinity)	>33	<1	3.6
Coyote Creek			
CC-3 (max salinity)	>33	<1	2.5
CC-9 (max salinity)	>33	8	3.2
So Bay @ Alviso			
SBN (2002 salinity)	>33	1	2.4
SBN (max salinity)	>33	<1	2.4
SBF (2002 salinity)	>33	2	5.2
SBF (max salinity)	>33	1	5.2
Bay @ Baumberg			
BBN (max salinity)	>33	2	3.3
BBF (max salinity)	>33	3	6.8

Figure 5. Comparison "Time to 5 mg/l DO" under Circulation Conditions with Predicted Residence Time

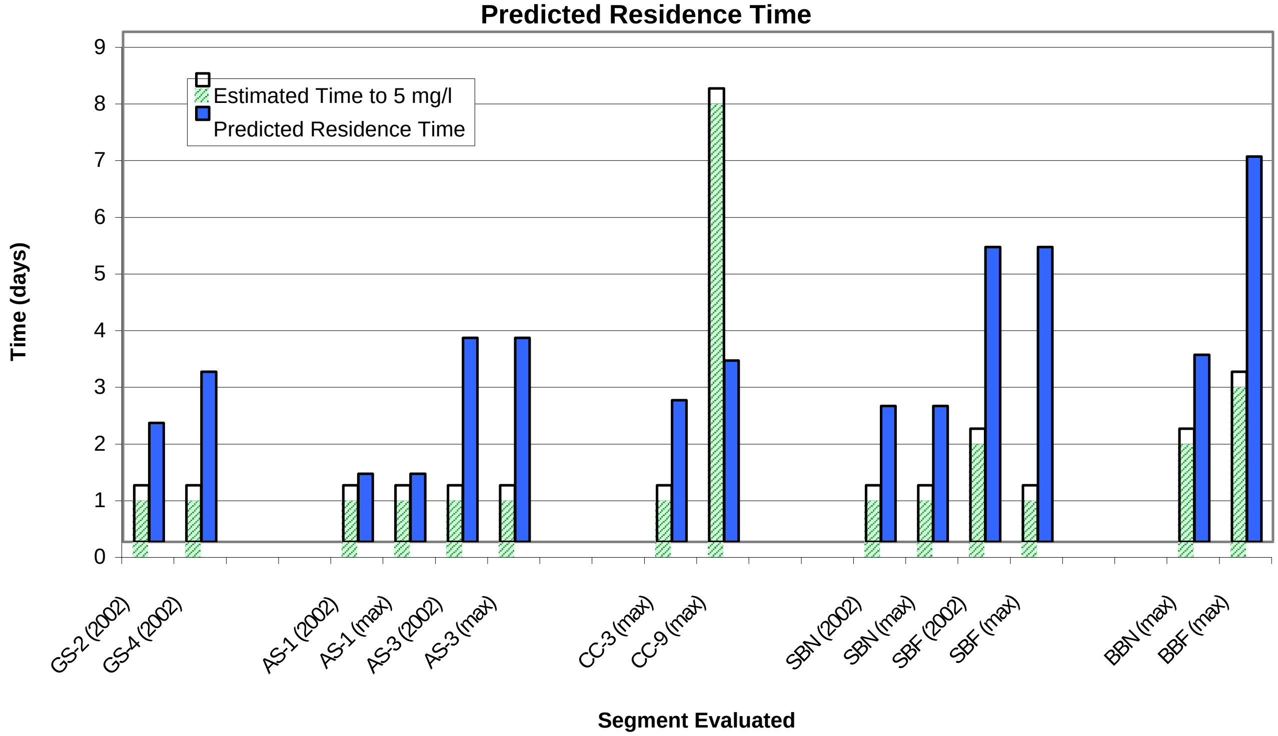


Table 8. Comparison of Estimated "Time to Reach 5 mg/l DO" with Predicted Residence Time during Spring Initial Release Period - in Diurnal Cycle of 8 hr light : 16 hr dark

Segment	Estimated Time to Reach 5 mg/l D.O. (days)		Estimated Residence Time (days)
	Existing	ISP	
Guadalupe Slough			
GS-2 (2002 salinity)	>15	>15	2.1
GS-4 (2002 salinity)	>15	>15	3.0
Alviso Slough			
AS-1 (2002 salinity)	>15	>15	1.2
AS-1 (max salinity)	>15	>15	1.2
AS-3 (2002 salinity)	>15	>15	3.6
AS-3 (max salinity)	>15	>15	3.6
Coyote Creek			
CC-3 (max salinity)	>15	>15	2.5
CC-9 (max salinity)	>15	>15	3.2
So Bay @ Alviso			
SBN (2002 salinity)	>15	>15	2.4
SBN (max salinity)	>15	>15	2.4
SBF (2002 salinity)	>15	>15	5.2
SBF (max salinity)	>15	>15	5.2
Bay @ Baumberg			
BBN (max salinity)	>15	>15	3.3
BBF (max salinity)	>15	>15	6.8

Figure 6. Comparison "Time to 5 mg/l DO" under Circulation Conditions with Predicted Residence Time

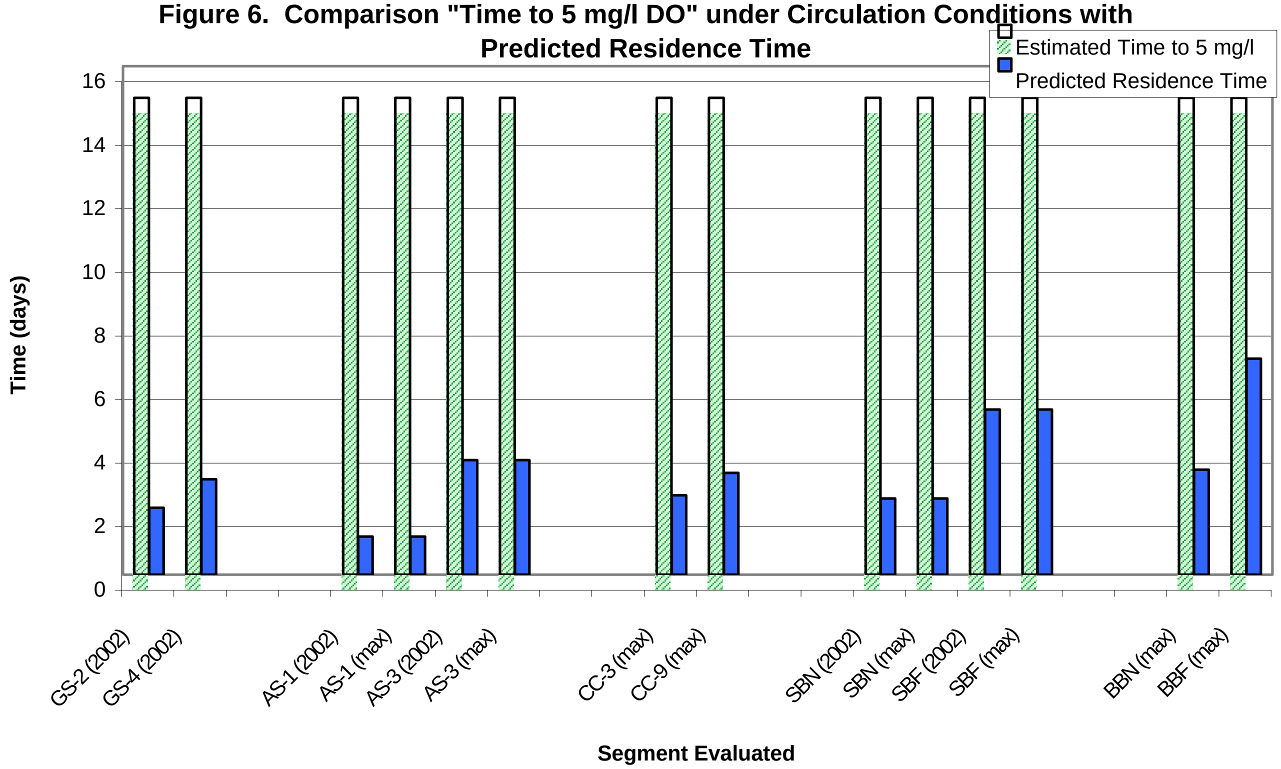


Table 9. Comparison of Estimated "Time to Reach 5 mg/l DO" with Predicted Residence Time during Spring Initial Release Period - in Diurnal Cycle of 16 hr light : 8 hr dark

Segment	Estimated Time to Reach 5 mg/l D.O. (days)		Estimated Residence Time (days)
	Existing	ISP	
Guadalupe Slough			
GS-2 (2002 salinity)	>14	>14	2.1
GS-4 (2002 salinity)	>14	>14	3.0
Alviso Slough			
AS-1 (2002 salinity)	>14	>14	1.2
AS-1 (max salinity)	>14	>14	1.2
AS-3 (2002 salinity)	>14	>14	3.6
AS-3 (max salinity)	>14	>14	3.6
Coyote Creek			
CC-3 (max salinity)	>14	>14	2.5
CC-9 (max salinity)	>14	>14	3.2
So Bay @ Alviso			
SBN (2002 salinity)	>14	>14	2.4
SBN (max salinity)	>14	>14	2.4
SBF (2002 salinity)	>14	>14	5.2
SBF (max salinity)	>14	>14	5.2
Bay @ Baumberg			
BBN (max salinity)	>14	>14	3.3
BBF (max salinity)	>14	>14	6.8

Figure 7. Comparison "Time to 5 mg/l DO" under Circulation Conditions with Predicted Residence Time

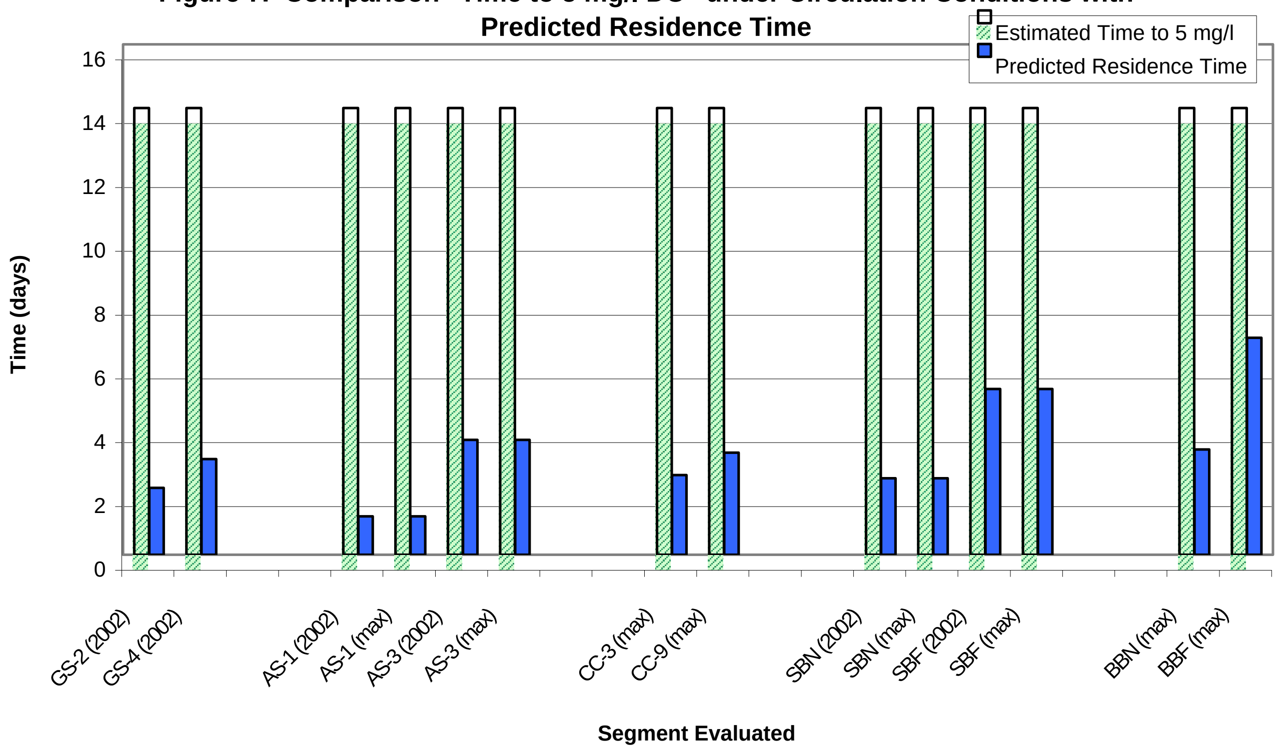


Figure 8. Comparison of Compositions of Formulated Mixtures vs Currently Predicted Initial Stewardship Period Mixtures for an Early Fall Discharge Period

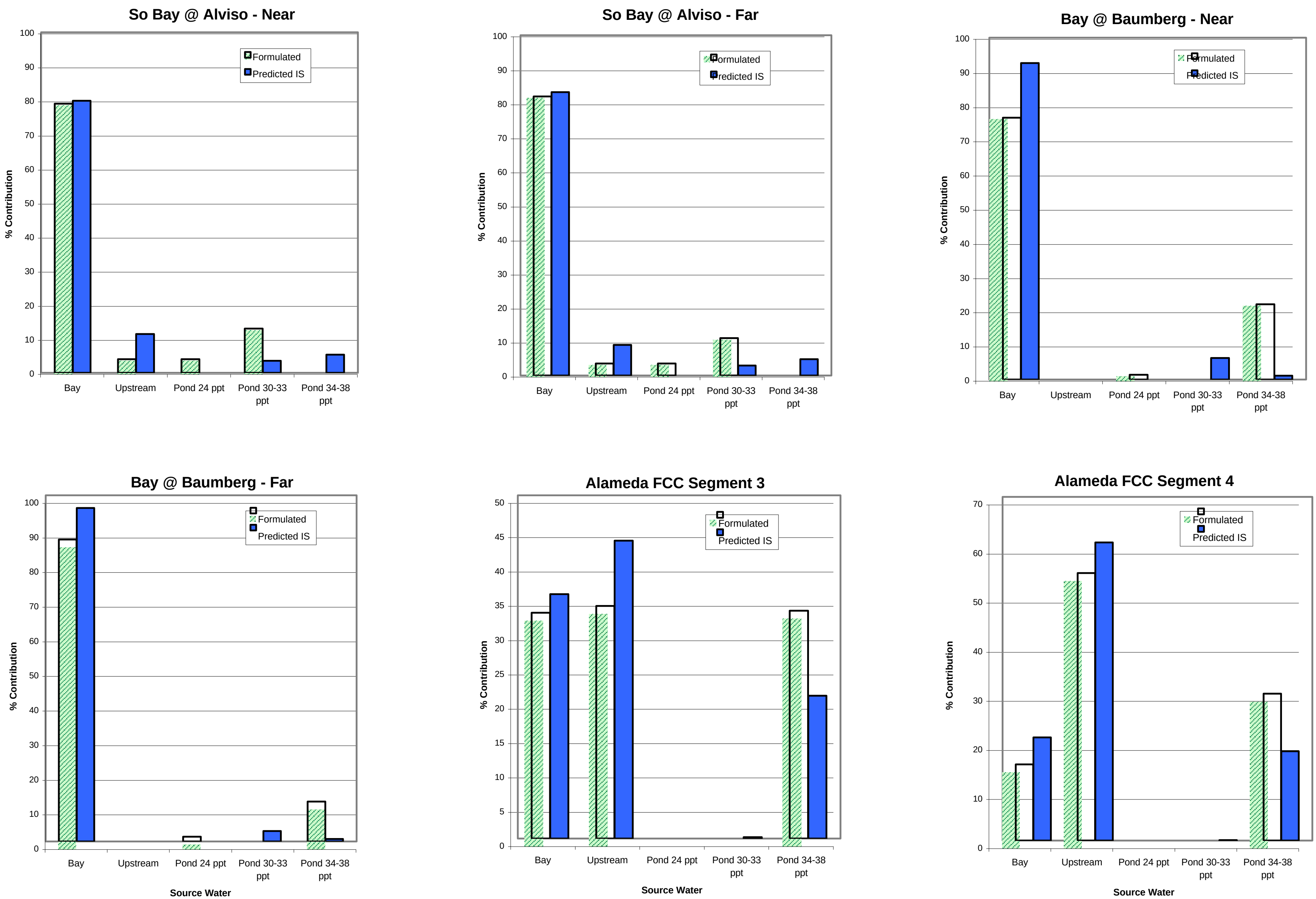


Figure 8 Cont'd. Comparison of Compositions of Formulated Mixtures vs Currently Predicted Initial Stewardship Period Mixtures for an Early Fall Discharge Period

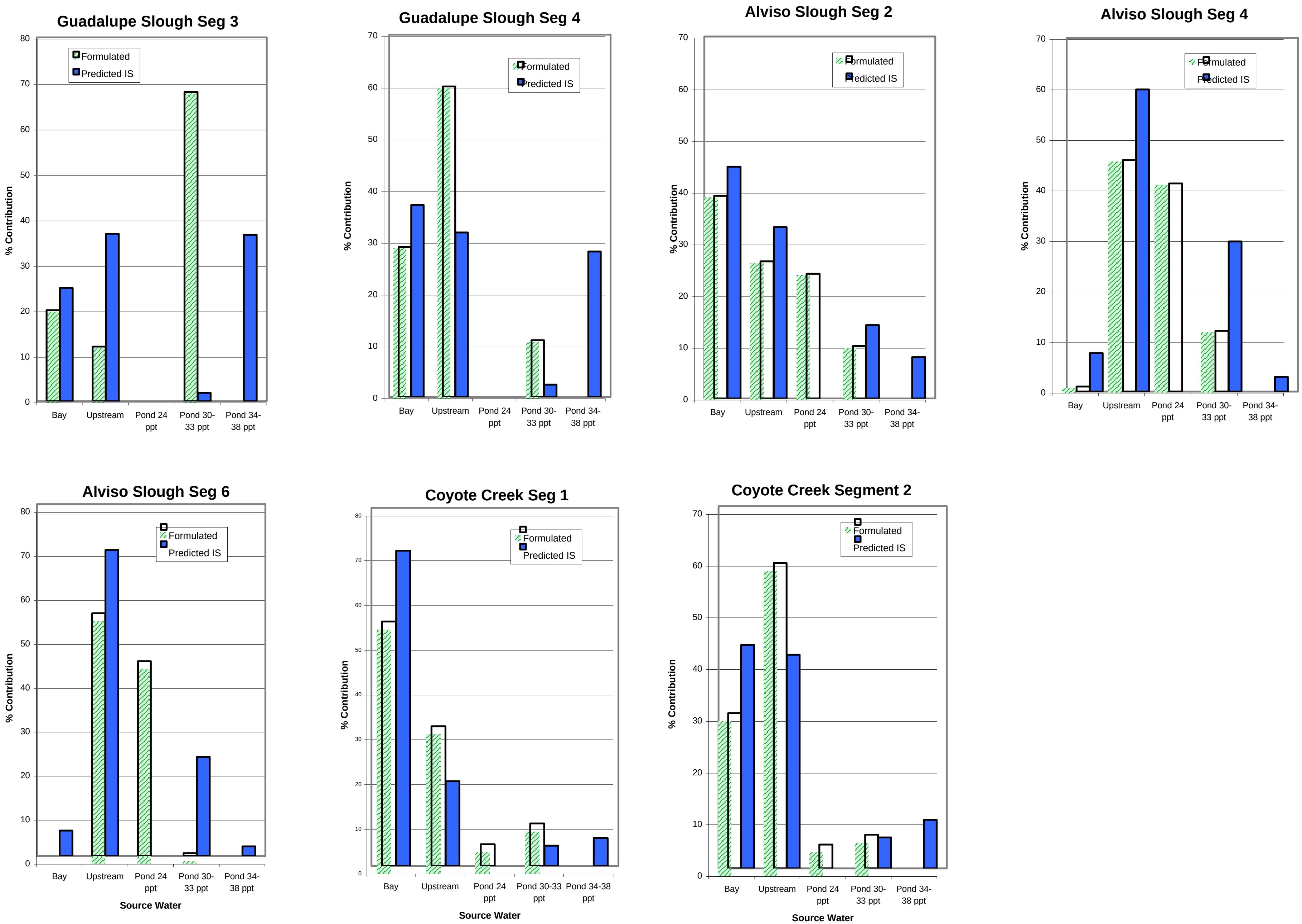


Figure 9. Comparison of Compositions of Formulated Mixtures vs Currently Predicted Initial Stewardship Period Mixtures for a Spring Initial Release Period - (based on 2002 Initial Pond Salinities)

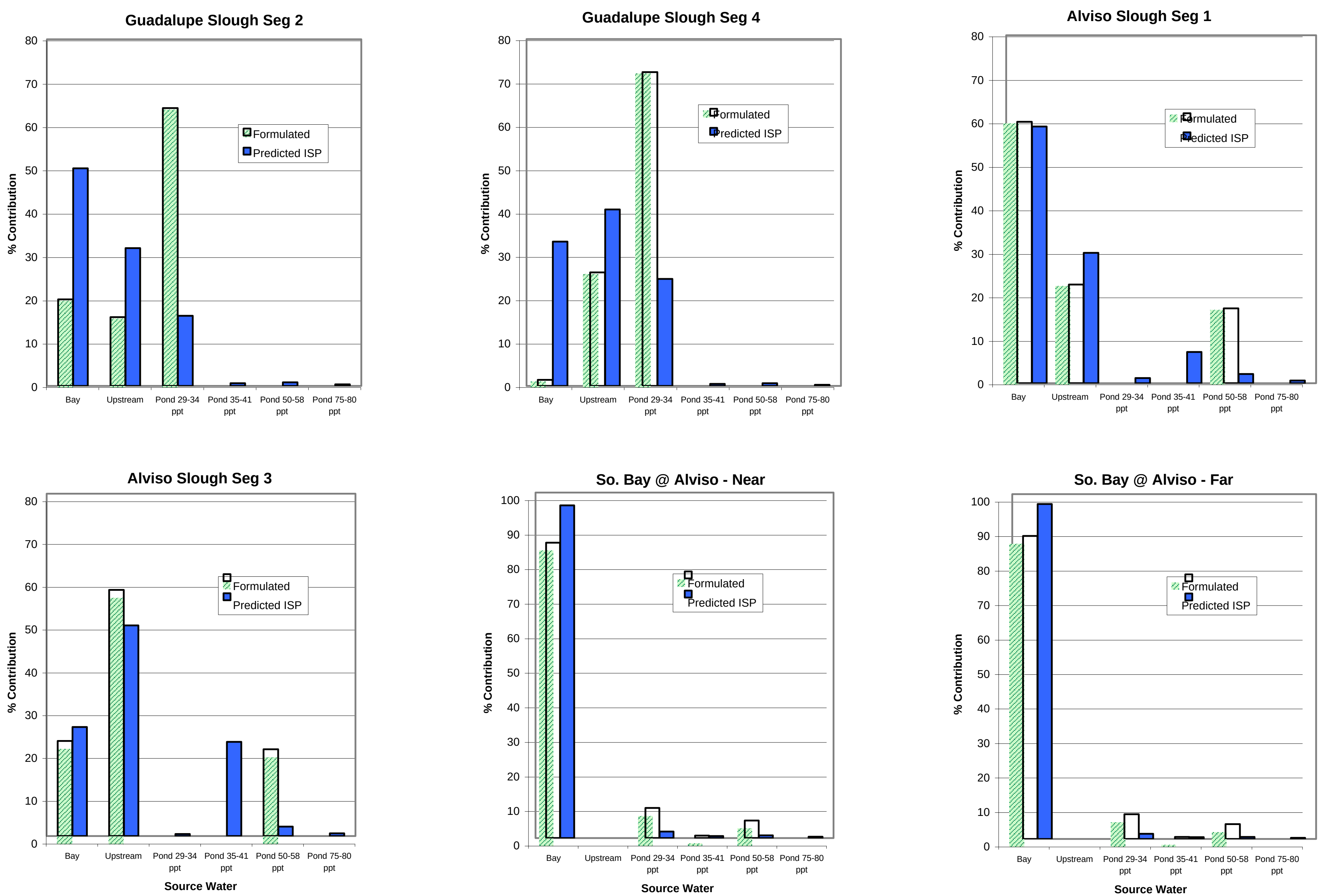
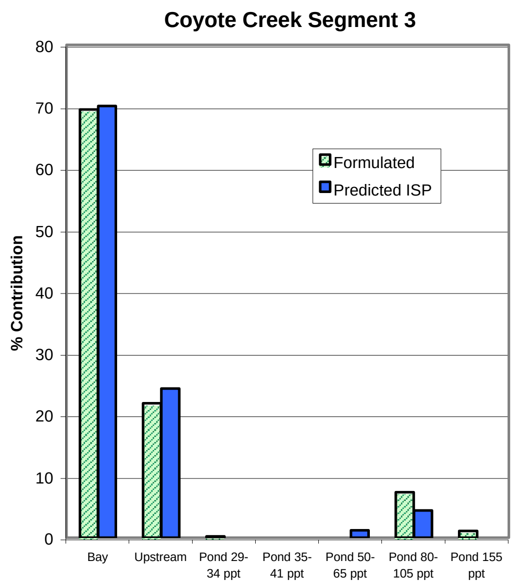
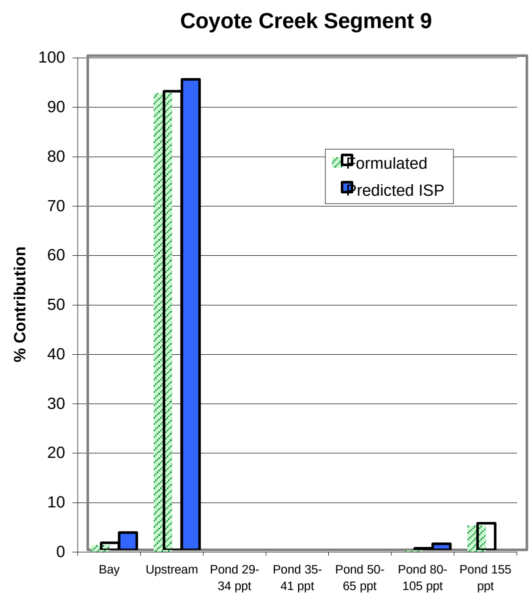
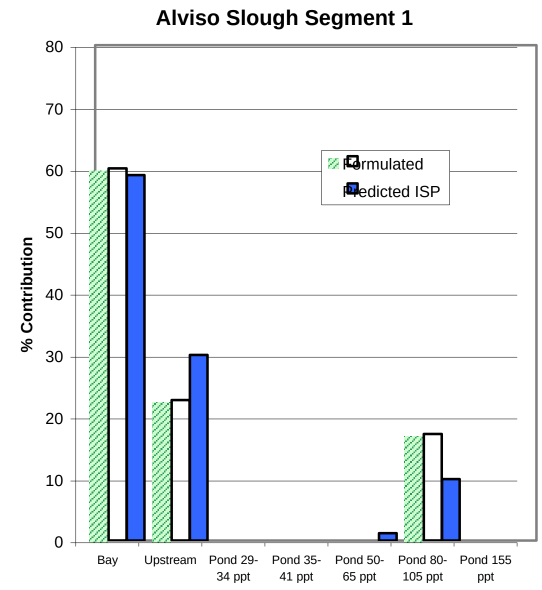
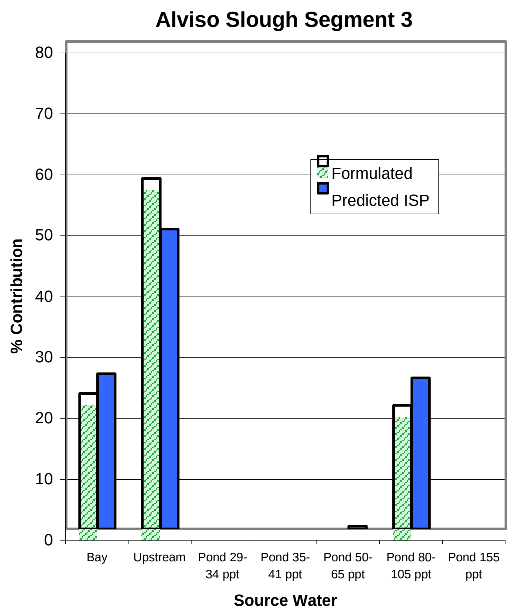


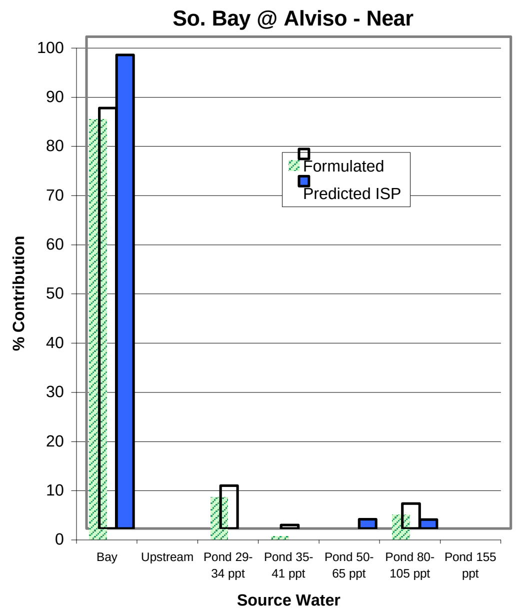
Figure 10. Comparison of Compositions of Formulated Mixtures vs Currently Predicted Initial Stewardship Period Mixtures for a Spring Initial Release Period - (based on Proposed Maximum Initial Pond Salinities)











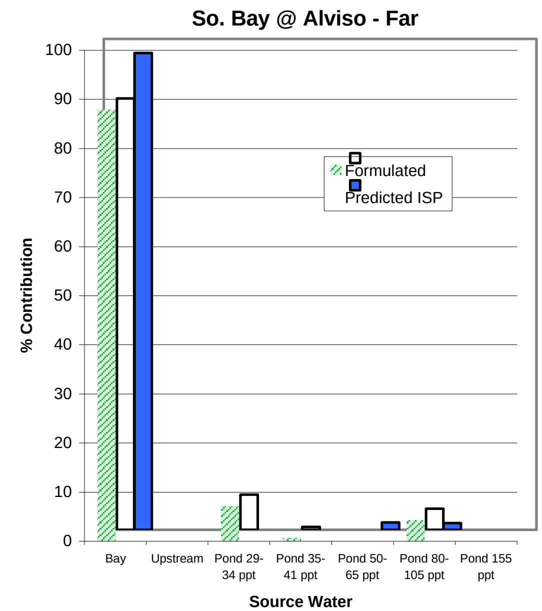
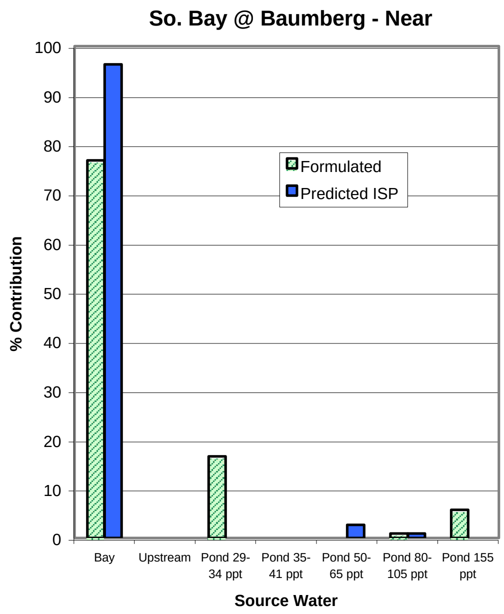


Figure 10 Cont'd. Comparison of Compositions of Formulated Mixtures vs Currently Predicted Initial Stewardship Period Mixtures for a Spring Initial Release Period - (based on Proposed Maximum Initial Pond Salinities)



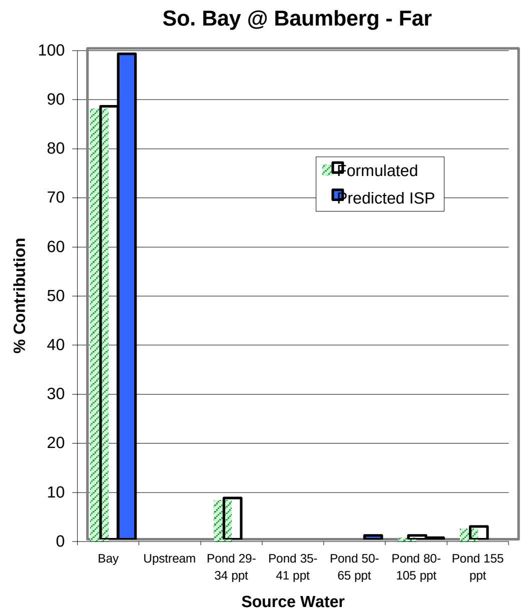
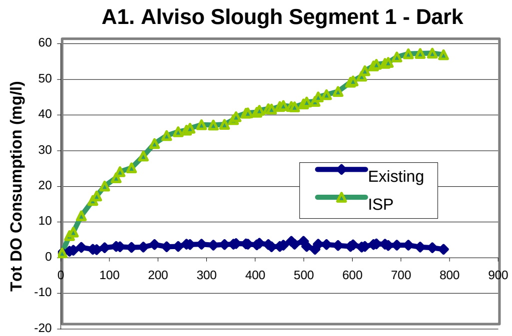
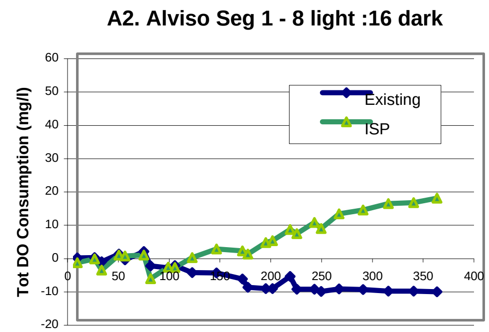


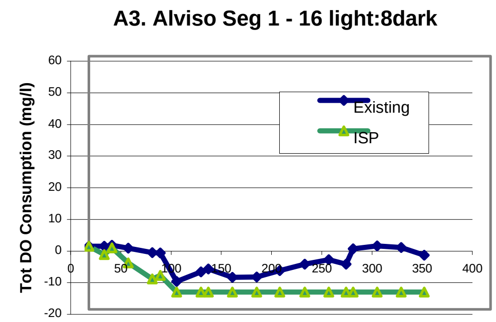
Figure 11. Sensitivity Analysis: How Salinity of Water Discharged Affects Oxygen Consumption in Bay and Slough Segments - during Spring Initial Release Period

a. Vary Salinity of Pond Water Discharged - 48 ppt vs 86 ppt - in <u>Alviso Slough Segment 1</u>

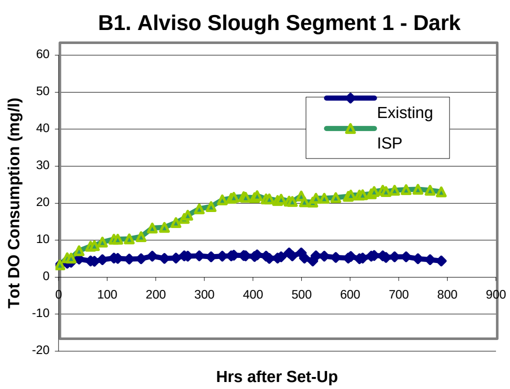
<u>Assume 86 ppt Discharge from A9</u>

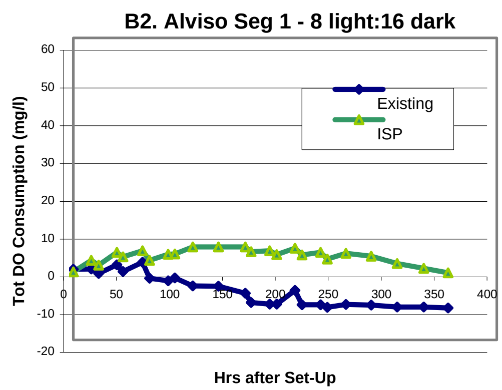






<u>Assume 48 ppt Discharge from A9</u>





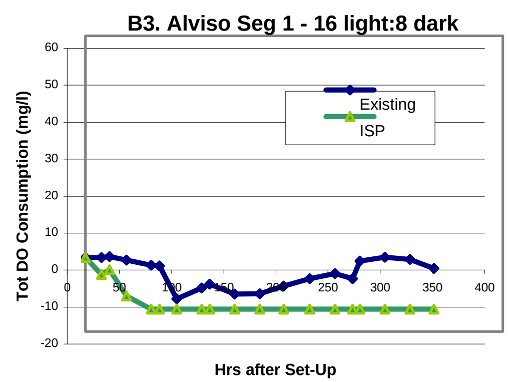
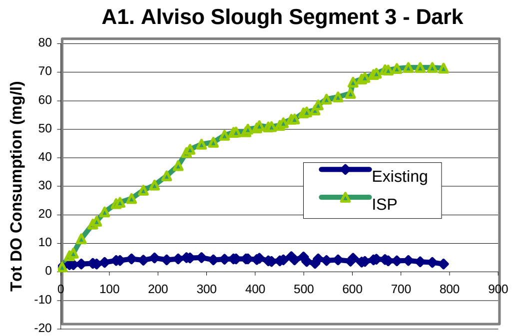
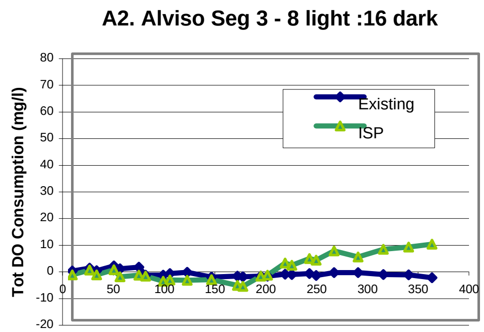


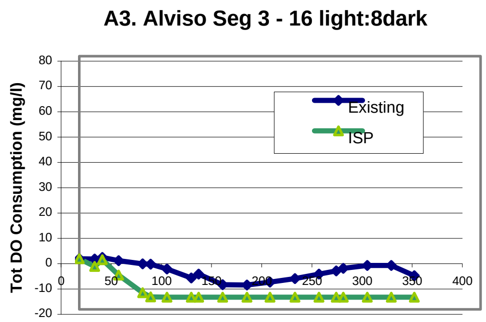
Figure 11 Cont'd. Sensitivity Analysis: How Salinity of Water Discharged Affects Oxygen Consumption in Bay and Slough Segments - during Spring Initial Release Period

b. Vary Salinity of Pond Water Discharged - 48 ppt vs 86 ppt - in Alviso Slough Segment 3

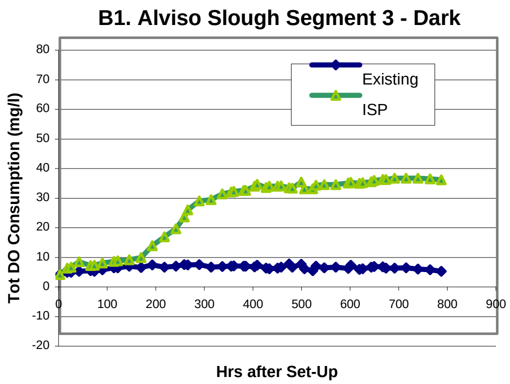
Assume 86 ppt Discharge from A9

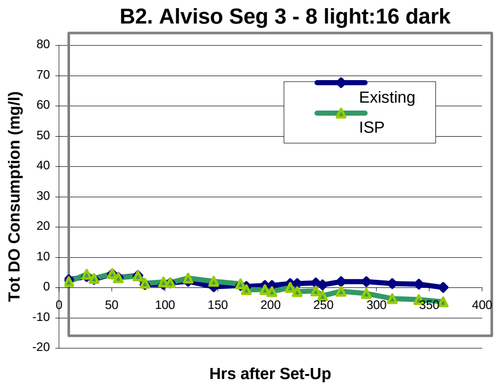






Assume 48 ppt Discharge from A9





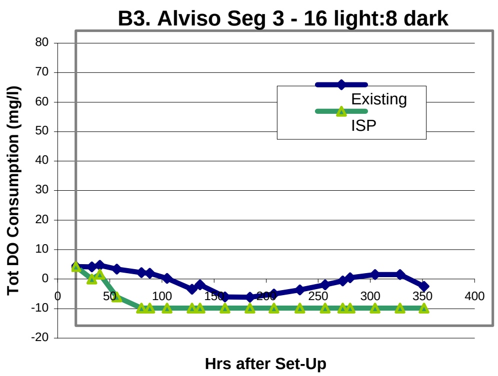
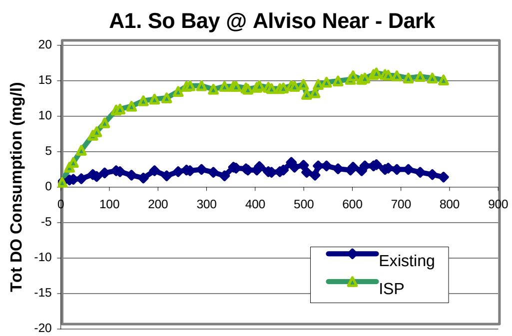
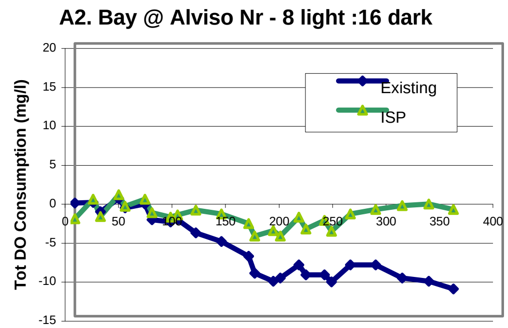


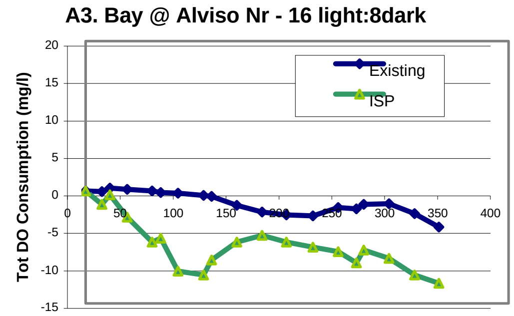
Figure 11 Cont'd. Sensitivity Analysis: How Salinity of Water Discharged Affects Oxygen Consumption in Bay and Slough Segments - during Spring Initial Release Period

c. Vary Salinity of Pond Water Discharged - 48 ppt vs 86 ppt - in <u>South Bay @ Alviso Near</u>

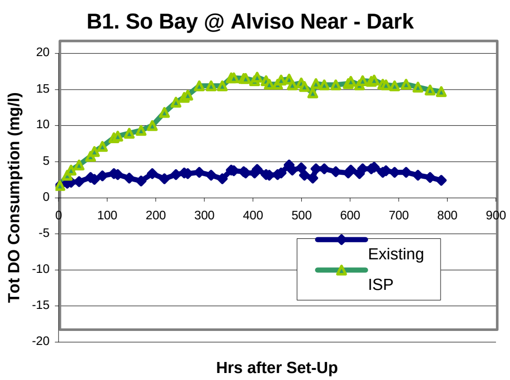
<u>Assume 86 ppt Discharge from A9</u>

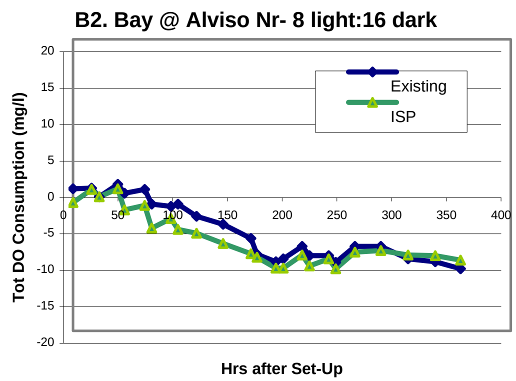






<u>Assume 48 ppt Discharge from A9</u>





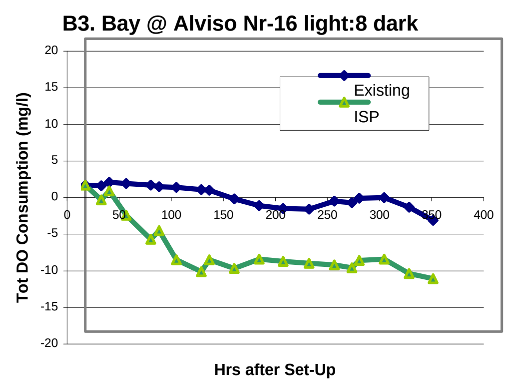
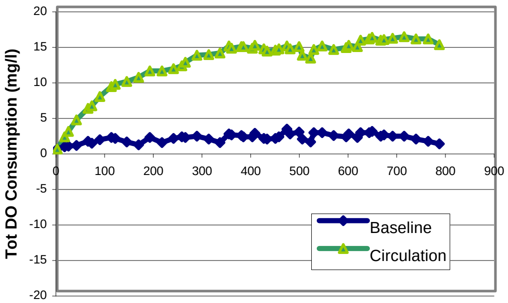


Figure 11 Cont'd. Sensitivity Analysis: How Salinity of Water Discharged Affects Oxygen Consumption in Bay and Slough Segments - during Spring Initial Release Period

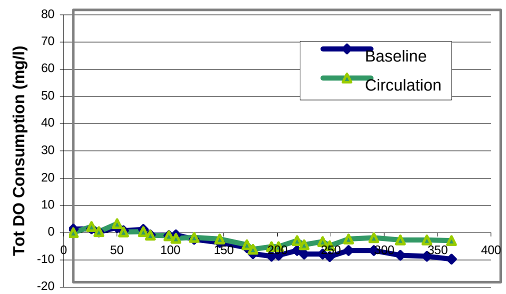
d. Vary Salinity of Pond Water Discharged - 48 ppt vs 86 ppt - in <u>South Bay @ Alviso Far</u>

<u>Assume 86 ppt Discharge from A9</u>

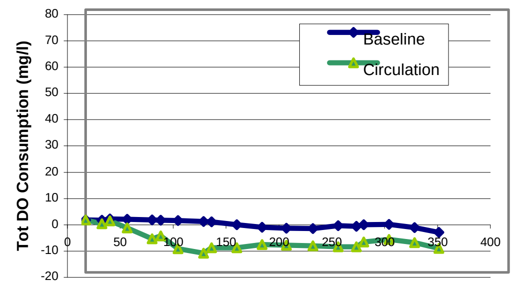
A1. So Bay @ Alviso Far - Dark



A2. Bay @ Alviso Fr - 8 light:16 dark

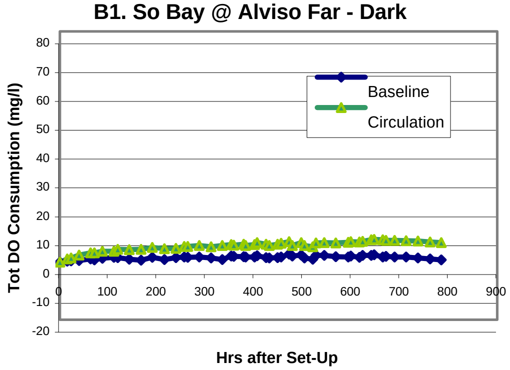


A3. Bay @ Alviso Fr - 16 light:8dark

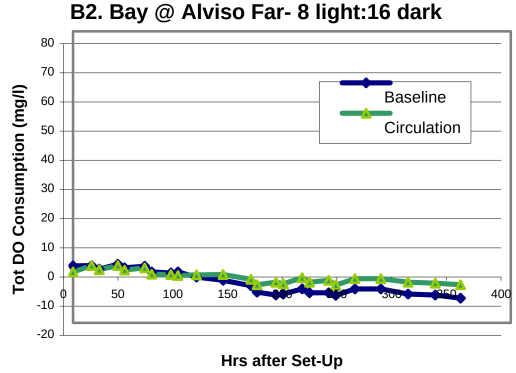


<u>Assume 48 ppt Discharge from A9</u>

B1. So Bay @ Alviso Far - Dark



B2. Bay @ Alviso Far- 8 light:16 dark



B3. Bay @ Alviso Far-16 light:8 dark

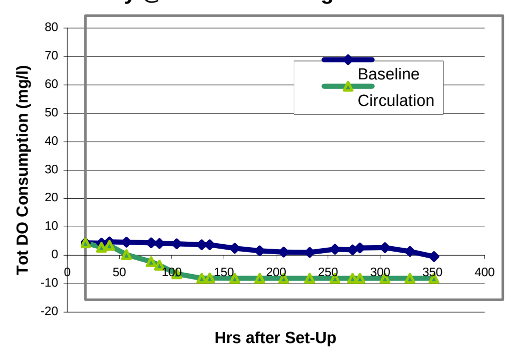
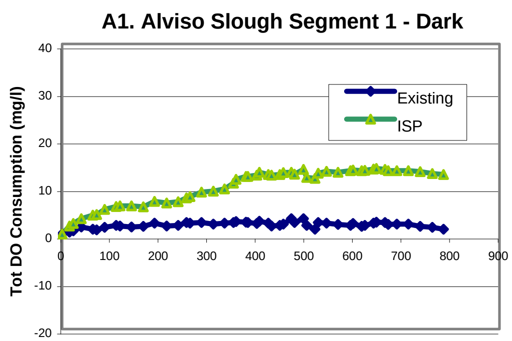
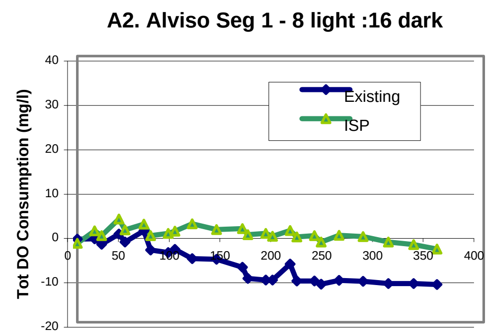


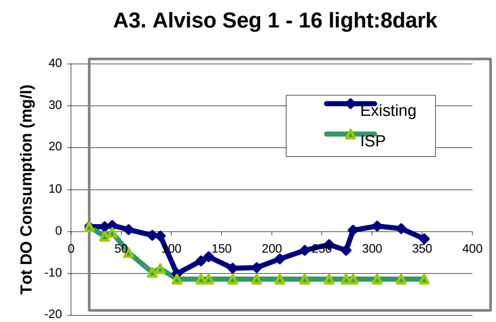
Figure 12. Sensitivity Analysis: How Amount of Water Discharged Affects Oxygen Consumption in Bay and Slough Segments - during Spring Initial Release Period

a. Vary Amount of Pond Water Discharged @ 48 ppt into Alviso Slough Segment 1

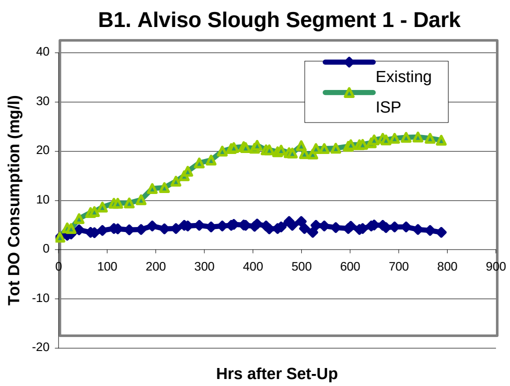
Assume 48 ppt Discharge from A9 - 50% Volume

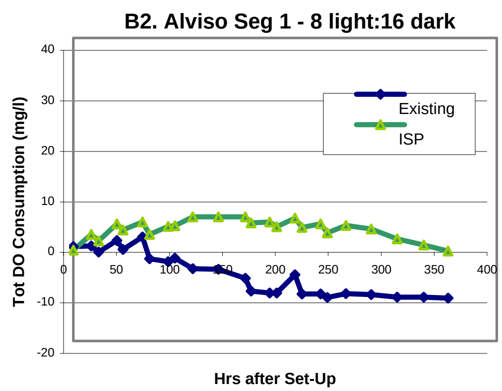






Assume 48 ppt Discharge from A9 - 100% Volume





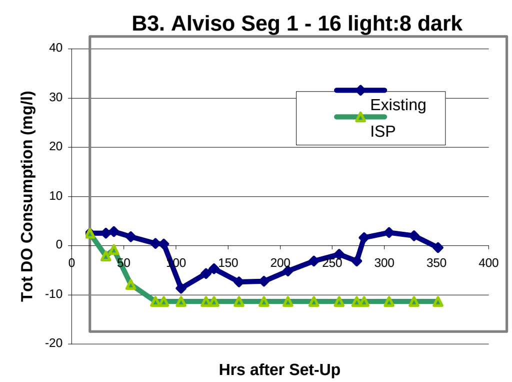
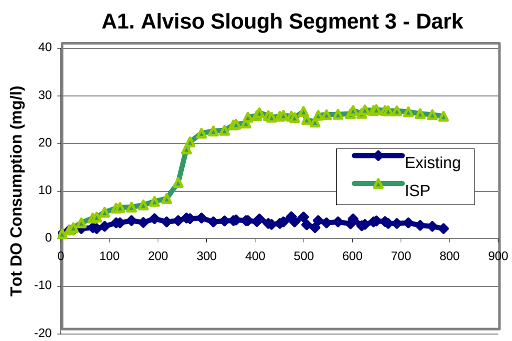
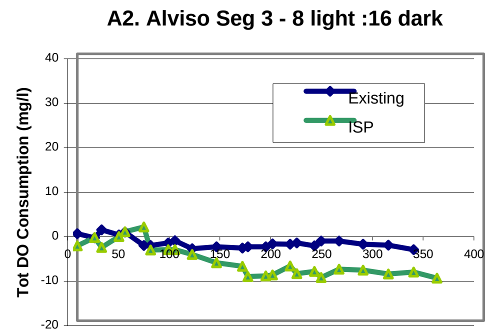


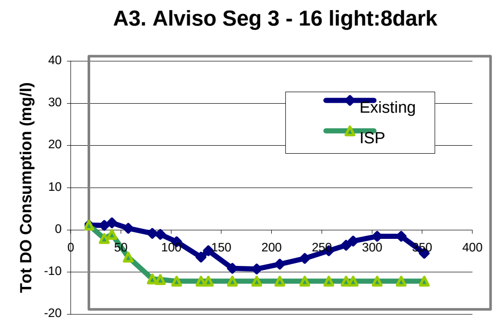
Figure 12 Cont'd. Sensitivity Analysis: How Amount of Water Discharged Affects Oxygen Consumption in Bay and Slough Segments - during Spring Initial Release Period

b. Vary Amount of Pond Water Discharged @ 48 ppt into Alviso Slough Segment 3

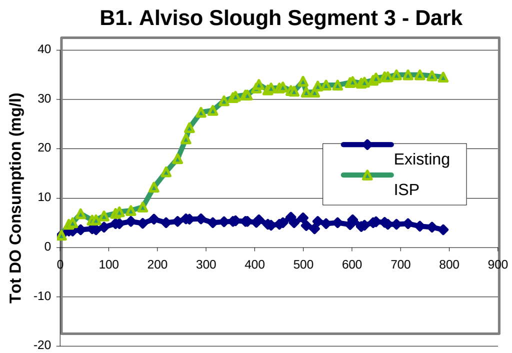
Assume 48 ppt Discharge from A9 - 50% Volume

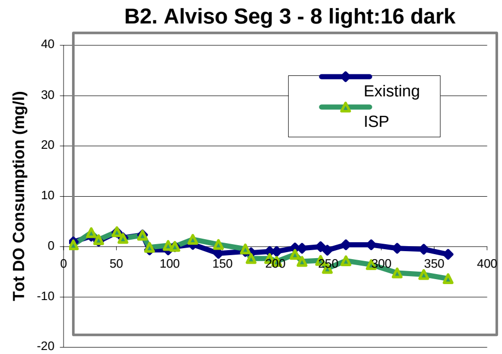


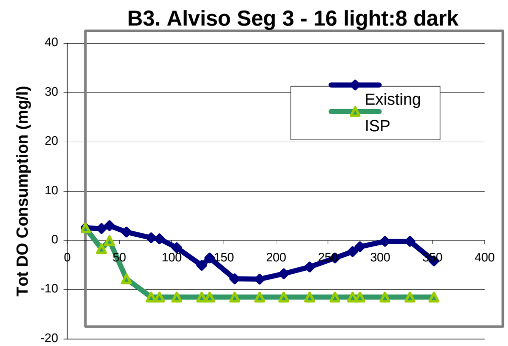




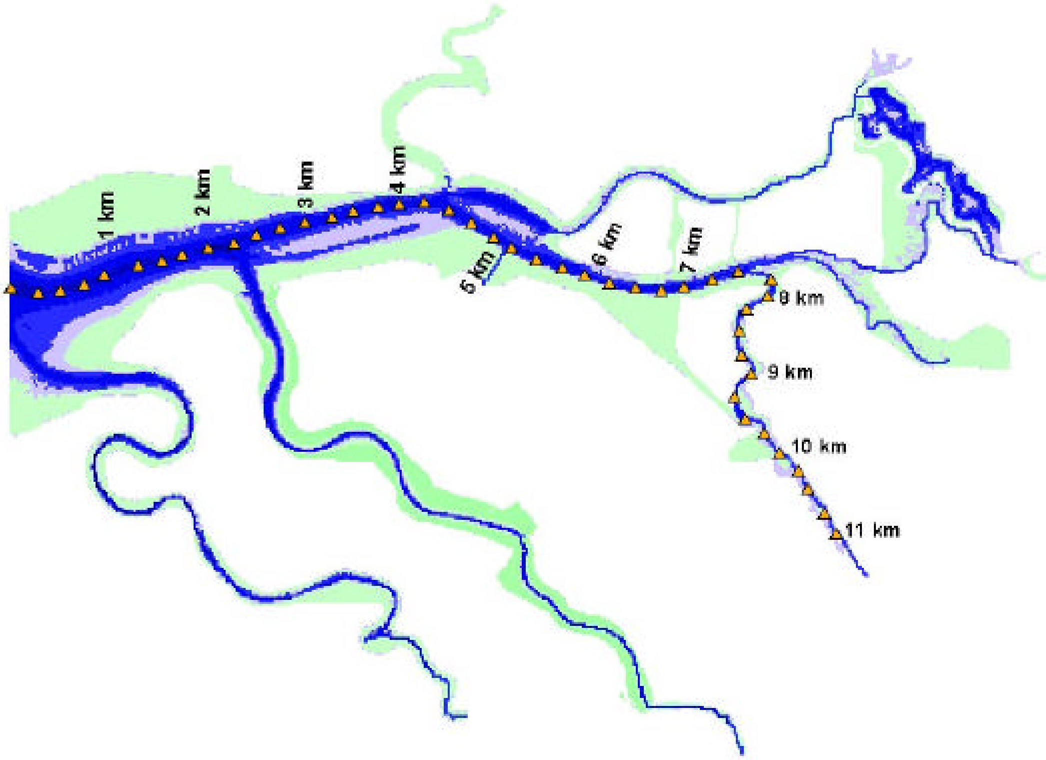
Assume 48 ppt Discharge from A9 - 100% Volume



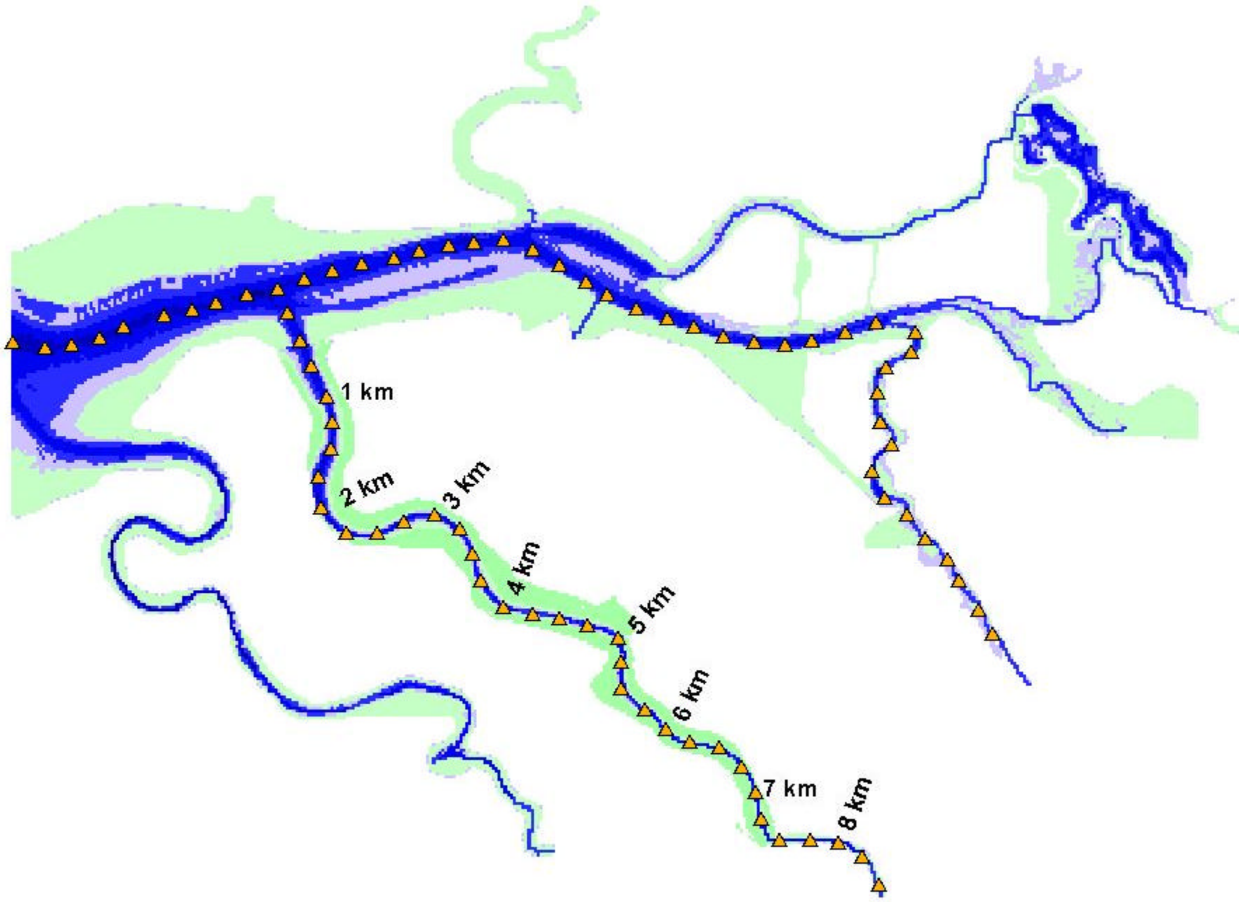




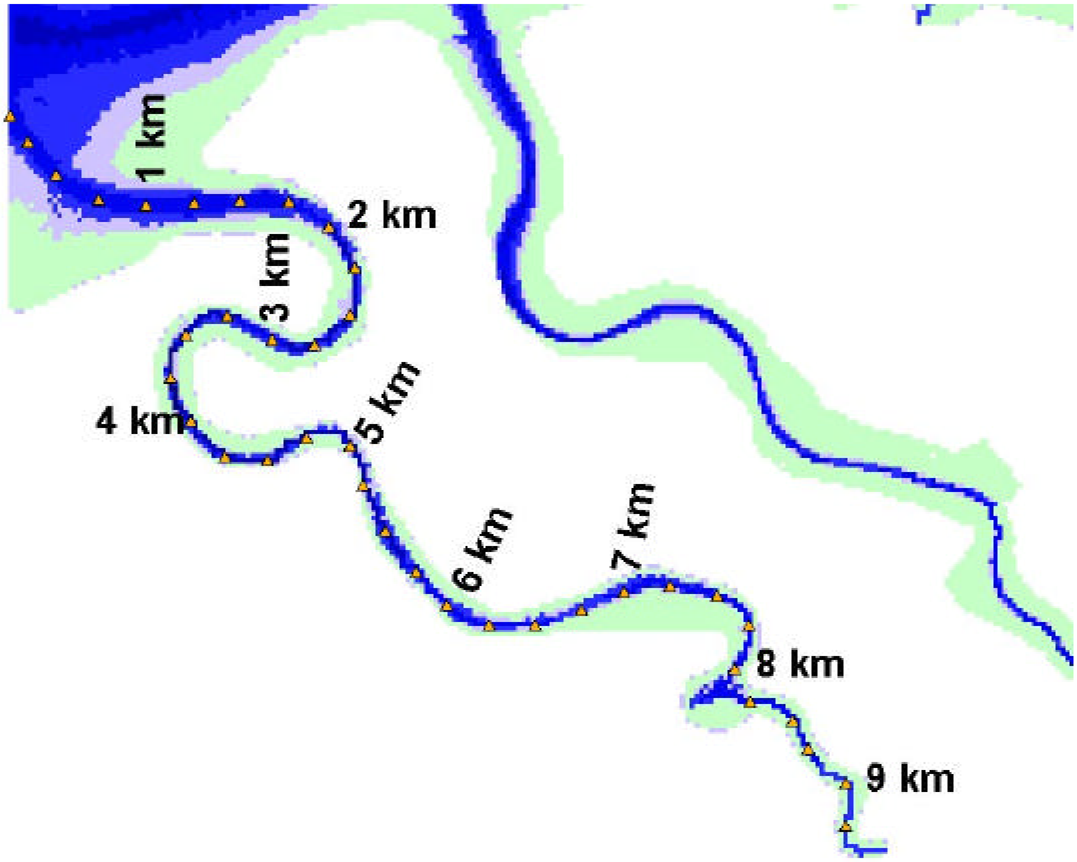
Appendix A Figure 1. Longitudinal transect stations along the centerline of Alameda Flood Control Channel at 250 meter increments.



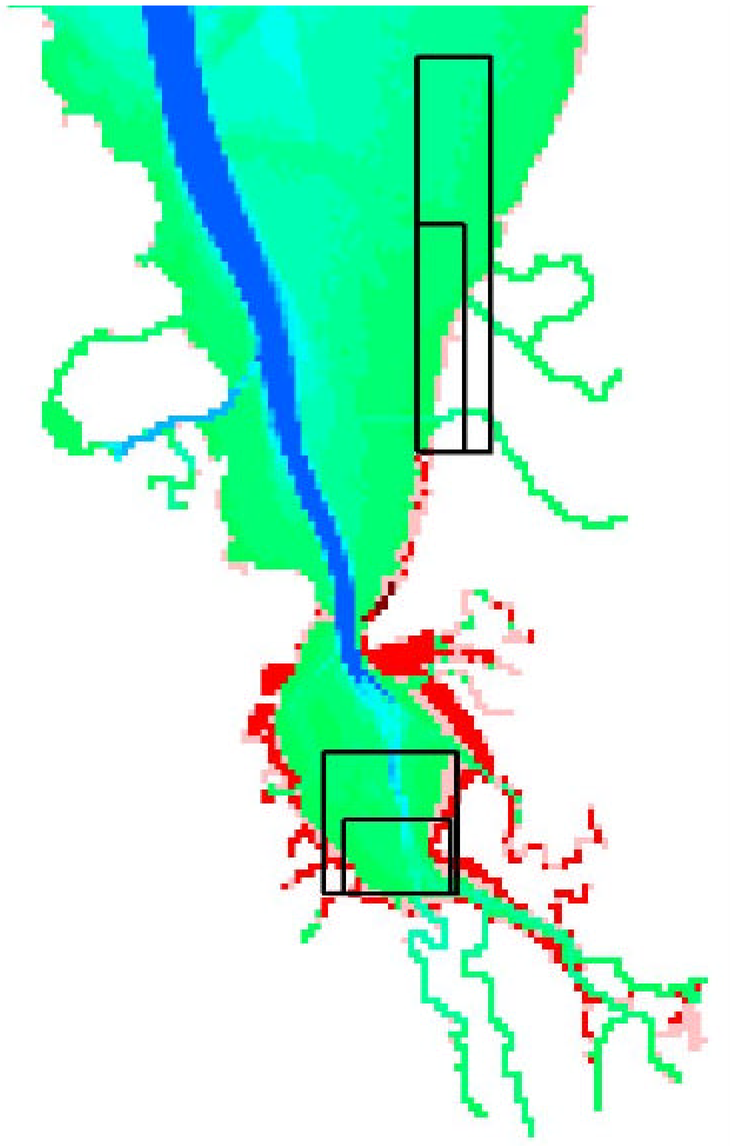
Appendix A Figure 2. Longitudinal transect stations along the centerline of Coyote Creek and Artesian Slough at 250 meter increments.



Appendix A Figure 3. Longitudinal transect stations along the centerline of Alviso Slough at 250 meter increments.



Appendix A Figure 4. Longitudinal transect stations along the centerline of Guadalupe Slough at 250 meter increments.



Appendix A Figure 5. Averaging areas established in San Francisco Bay near the Alviso and Baumberg Units.

EVALUATION OF THE POTENTIAL FOR IMPACTS TO AQUATIC LIFE DUE TO THE PRESENCE OF HEAVY METALS IN THE SALINE POND WATER CIRCULATED DURING THE INITIAL STEWARDSHIP PERIOD

Prepared by
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1. OVERVIEW

Based on discussions with staff of the San Francisco Regional Water Quality Control Board, the presence of heavy metals in the saline pond waters which would be circulated into receiving water bodies in the South Bay (i.e., segments of the bay proper and adjoining sloughs) during the Initial Stewardship Period was identified as an area of particular interest. The concern was that the saline pond waters might contain elevated concentrations of heavy metals which could exceed applicable water quality objectives and, consequently, would have the potential to adversely impact aquatic life.

As described in this document, an evaluation was performed to determine if heavy metals in the circulated pond waters are expected to exceed water quality objectives and, if so, to estimate the magnitude and duration of any potential impacts to aquatic life. The results of this evaluation indicate that 8 of the 10 heavy metals studied are not expected to exceed water quality objectives at any time in the Initial Stewardship Period (i.e., during either initial release or continuous circulation). On the other hand, this evaluation indicates that there is a potential for both nickel and mercury to be present in the circulated pond waters in concentrations greater than their applicable water quality objectives. However, these exceedences, if they occur, will be primarily limited to the Initial Release Period (i.e., approximately the first two months of circulation) and will result in only minor elevations in concentrations in limited segments of the receiving water bodies. In addition, in those segments where nickel and mercury concentrations are predicted to increase slightly, there is little potential for harm to aquatic life associated with these increases. The evaluation upon which these conclusions are based is described in the following sections of this document.

2. APPROACH

The concern about the presence of toxic chemicals and their possible impact on aquatic organisms in segments of the receiving waters was evaluated in a multi-step fashion. First, applicable water quality objectives for heavy metals were identified for the water bodies into which pond water would be circulated. Second, representative samples of pond water were sampled from the Alviso and Baumberg Units and analyzed to determine the concentrations of heavy metals present in pond water and estimate how these concentrations vary with salinity. Third, based on the predicted salinities of the proposed discharges, these measured metal concentrations were used to estimate the range of metal concentrations that would be present in each proposed discharge during both initial release and continuous circulation portions of the Initial Stewardship Period. Fourth, for each discharge, the predicted concentration range of each heavy metal was compared against its operative water quality objective to determine if there was a potential for harm to aquatic life. Fifth, for each metal which was predicted to occur in a discharge in concentrations that exceed its objective, an evaluation was made to estimate the significance of that exceedence.

3. APPLICABLE WATER QUALITY OBJECTIVES

The applicable water quality objectives for heavy metals in the water bodies into which saline pond water will be circulated are summarized in Table 1. For discharges from the Alviso unit, the operative water quality objectives, except for copper and nickel, are established by the USEPA and published in the Federal Register as the California Toxics Rule (40CFR 131.38), which apply to all waters of the San Francisco Bay Estuary south of the Dumbarton Bridge. The operative objectives for copper and nickel in this region of the bay have been established by the San Francisco Regional Water Quality Control Board as site-specific objectives. For discharges from the Baumberg and the West Bay units, the operative water quality objectives are specified in the San Francisco Bay Water Quality Control Plan (SFRWQCB 1995) and apply to all waters of the S.F. Bay Estuary north of the Dumbarton Bridge.

4. ANALYSIS OF HEAVY METALS IN POND SAMPLES

In October 2002, samples of pond water were collected from ten ponds in the Alviso and Baumberg units. These samples were analyzed, by Frontier Geoscience Laboratories in Seattle, Washington, for salinity and the total and dissolved concentrations of the suite of ten heavy metals for which water quality objectives exist (i.e., arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc). The results of these analyses are summarized in Table 2 and are provided in detail in a report by S.R. Hansen & Associates entitled "Determination of Heavy Metal Concentrations in the Water Coloumn of Alviso and Baumberg Pond Samples Collected October 24-25, 2002". This report is provided in full as an appendix to the application for discharge.

5. ESTIMATION OF HEAVY METAL CONCENTRATIONS IN EACH DISCHARGE

Estimates were made of the heavy metal concentrations that would occur in each of the proposed discharges during both the initial release and continuous circulation portions of the Initial Stewardship Period. These estimates are presented in Tables 4 and 5 for dissolved and total concentrations, respectively. It should be noted that two estimates are made for the Initial Release Period. The first is based on metals concentrations estimated for ponds discharging with salinities equal to those observed in 2002. The second is based on metals concentrations estimated for ponds discharging at "proposed maximum" salinities.

The approach used in making estimates of heavy metal concentrations in pond discharges is described in detail in the "Characterization of Discharge" section of the application for discharge. In brief, a three step process was used. First, the range of salinities that would occur in each of the discharges during both the Initial Release and Continuous Circulation Periods was predicted (Table 3). Second, for each predicted salinity range, the subset of samples collected in October 2002 that best matched that salinity range was identified (as specified in Tables 4 and 5). Third, the analytical results from each subset of samples, so identified, was used to estimate the range of concentrations that each heavy metal would exhibit in each discharge during the Initial Release and Continuous Circulation Periods.

6. COMPARISON WITH WATER QUALITY OBJECTIVES

By comparing the objectives in Table 1 with the predicted range of metal concentrations in Tables 4 and 5, it can be seen that of the ten heavy metals which were considered, eight (arsenic, cadmium, chromium, copper, lead, selenium, silver, and zinc) are predicted to occur in all of the discharges, during both Initial Release and Continuous Circulation Periods, at concentrations that are below applicable water quality objectives and, therefore, are not considered a risk to aquatic life. On the other hand, two metals, nickel and mercury, are predicted to occur, in several discharges, in concentrations greater than their applicable water quality objectives and, therefore, have a potential for causing adverse impacts in the receiving waters.

The comparison of the estimated nickel and mercury concentrations in each discharge with the applicable water quality objectives are summarized in Tables 6 and 7. As can be seen in these tables, the discharges in which water quality objectives may be exceeded are as follows:

Alviso Unit for Dissolved Nickel

- Discharge A7 during Initial Release (only under proposed maximum salinities)
- Discharge A14 during Initial Release (only under proposed maximum salinities)
- Discharge A16 during Initial Release (only under proposed maximum salinities)

Baumberg Unit for Total Nickel

- Discharge 2 during Initial Release and Continuous Circulation
- Discharge 10 during Initial Release and Continuous Circulation
- Discharge 2C during Initial Release and Continuous Circulation
- Discharge 8A during Initial Release and Continuous Circulation
- Discharge 6A during Initial Release and Continuous Circulation

Baumberg Unit for Total Mercury

- Discharge 2 during Initial Release (only under proposed maximum salinities)
- Discharge 10 during Initial Release (only under proposed maximum salinities)
- Discharge 2C during Initial Release (only under proposed maximum salinities)
- Discharge 8A during Initial Release (proposed maximum & 2002 salinities)
- Discharge 6A during Initial Release (only under proposed maximum salinities)

The potential of each of these metals to cause adverse impacts to the aquatic community at risk in the receiving waters is addressed in below.

7. EVALUATION OF NICKEL DISCHARGED FROM ALVISO PONDS

For waters south of the Dumbarton Bridge, which includes the receiving waters into which the Alviso Unit discharges will enter, the applicable water quality site-specific objective is 11.9 ug/l dissolved nickel (as established by the S.F. Regional Water Quality Control Board). As illustrated in Table 6, it is estimated that, under certain worst-case conditions, the water discharged from some of the Alviso salt ponds during the Initial Stewardship Period may contain dissolved concentrations of nickel that will exceed this objective. Exceedences are not predicted to occur for any of the discharges during the Continuous Circulation Period (dissolved nickel concentrations estimated to range from 3.1 to 8.05 ug/l) or during the Initial Release Period if the salinity of the discharges are similar to those that occurred in 2002 (dissolved nickel concentrations estimated to range from 3.1 to 10.8 ug/l). However, if the salinities of the discharges during the Initial Release Period reach their proposed maximum values, the estimated dissolved nickel concentrations could exceed the nickel objective in the discharges from Pond A16 (estimated range from 4.96 to 19.7 ug/l), Ponds A7 and A14 (estimated range from 4.96 to 12.8 ug/l), and the Island Ponds A19, A20, and A21 (estimated range from 4.96 to 19.7 ug/l). It should be emphasized that these predicted exceedences of the dissolved nickel water quality objective would only occur under worst-case salinity conditions and would be limited to a portion of the Initial Release Period (i.e., less than 2 months).

Three receiving water bodies could potentially be impacted by the discharge, from the Alviso Unit, of pond water containing concentrations of dissolved nickel in excess of the water quality objective. These are Alviso Slough (which will receive Pond A7 discharge), Coyote Creek and Artesian Slough (which will receive Pond A14 and Pond A16 discharges), and South Bay proper (which will receive all Alviso Unit discharges). To evaluate the impact on these water bodies resulting from these discharges, a four step procedure was performed. First, the receiving water body in question was divided into segments. Second, using mathematical models, on a weekly basis, the average proportions of the various types of water that would occur in each segment (i.e., bay water, upstream creek or slough water, pond water) were predicted for existing and initial release conditions. Third, based on the available analytical data, the range of concentrations of dissolved nickel in each contributing water type was estimated. Fourth, by combining the proportions of each water type with their associated dissolved nickel concentrations, a weighted-average estimate was made of the concentrations of dissolved nickel in each segment under existing and initial release conditions and the difference between these estimates quantified how dissolved nickel concentrations changed in each segment due to the pond discharges. The results of these evaluations are described below.

Alviso Slough – Initial Release (Proposed Maximum Salinity) – The segmentation of Alviso Slough is illustrated in Figure 1. The primary water types that would be found in these segments are bay water and Guadalupe River water under existing conditions and bay water, Guadalupe River water, and Pond A7 discharge under initial release conditions. As indicated in Tables 6 and 8, the range of concentrations of dissolved nickel in each of these water types during April and May (when initial release is expected to occur) are 4.96 to 12.8 ug/l for Pond A7, 2.1 to 4.3 ug/l for Guadalupe River, and 1.8 to 2.9 ug/l for bay water. Based on these data coupled with mixture estimates, the concentration of dissolved nickel was predicted for each segment of Alviso Slough under existing and initial release conditions for an eight week period, April 1 to May 26. These predictions were made under both worst-case conditions (i.e., maximum Ni concentrations for bay, river, and Pond A7) and average-case conditions (i.e., mean Ni concentrations for bay and river and maximum concentration for Pond A7).

The predicted concentrations of dissolved nickel in Alviso Slough for each of the eight weeks (i.e., April 1 – May 26) are presented in Appendix A, along with the data used in making these predictions. Table 9 summarizes predictions for two of the eight weeks – during the third week of April when dissolved nickel concentrations in Alviso Slough are predicted to be the highest and during the last week in May when the high salinity water has been almost completely pushed out of Pond A7 and the dissolved nickel concentrations in Alviso Slough are predicted to be the lowest. Predictions for these two weeks of the Initial Release Period are illustrated in Figures 5 and 6. These figures provide a comparison between existing and initial release conditions and illustrate where, if at all, the water quality objective for dissolved nickel of 11.9 ug/l is exceeded. Based on these predictions, the discharge from Pond A7 at maximum nickel concentrations is not predicted to cause an exceedence of the nickel water quality objective in any segment of Alviso Slough at any time during the Initial Release Period and, therefore, does not pose a threat to the aquatic community in the slough.

Coyote Creek and Artesian Slough – Initial Release (Proposed Maximum Salinity) – The segmentation of Coyote Creek and Artesian Slough is illustrated in Figure 2. The primary water types that would be found in these segments are bay water and Coyote Creek water (i.e., primarily San Jose/Santa Clara wastewater discharge) under existing conditions and bay water, Coyote Creek water, and Ponds A14 and A16 discharges under initial release conditions. As indicated in Tables 6 and 8, the range of concentrations of dissolved nickel in each of these water types during April and May (when initial release is expected to occur) are 4.96 to 12.8 ug/l for Pond A14, 4.96 to 19.7 ug/l for Pond A16, 3.0 to 5.6 ug/l for Coyote Creek, and 1.8 to 2.9 ug/l for bay water. Based on these data coupled with mixture estimates, the concentration of dissolved nickel was predicted for each segment of Coyote Creek and Artesian Slough under existing and initial release conditions for an eight week period, April 1 to May 26. These predictions were made under both worst-case conditions (i.e., maximum Ni concentrations for bay, river, and Ponds A14 and A16) and average-case conditions (i.e., mean Ni concentrations for bay and river and maximum concentration for Pond A14 and A16).

The predicted concentrations of dissolved nickel in Coyote Creek/Artesian Slough for each of the eight weeks (i.e., April 1 – May 26) are presented in Appendix B, along with the data used in making these predictions. Tables 10a and 10b summarize predictions for three of the eight weeks – during the first week of April when dissolved nickel concentrations in Artesian Slough are predicted to be the highest, during the second week of April when dissolved nickel concentrations in Coyote Creek are predicted to be the highest, and during the last week in May when the high salinity water has been almost completely pushed out of Ponds A14 and A16 and the dissolved nickel concentrations in Coyote Creek/Artesian Slough are predicted to be the lowest. Predictions for these three weeks of the Initial Release Period are illustrated in Figures 7-10. These figures provide a comparison between existing and initial release conditions and illustrate where, if at all, the water quality objective for dissolved nickel of 11.9 ug/l is exceeded. Based on these predictions, the discharges from Ponds A14 and A16 at maximum nickel concentrations are not predicted to cause an exceedence of the nickel water quality objective in any segment of Coyote Creek/Artesian Slough at any time during the Initial Release Period and, therefore, do not pose a threat to the aquatic community in these water bodies.

South Bay Proper – Initial Release (Proposed Maximum Salinity) – The segmentation of South Bay in the vicinity of the Alviso Unit is illustrated in Figure 3. The primary water types that would be found in these segments are bay water and Coyote Creek water (i.e., primarily San

Jose/Santa Clara wastewater discharge) under existing conditions and bay water, Coyote Creek water, and Ponds A2W, A3W, A7, A14 and A16 discharges under initial release conditions. As indicated in Tables 6 and 8, the range of concentrations of dissolved nickel in each of these water types during April and May (when initial release is expected to occur) are 4.96 to 10.8 ug/l for Ponds A2W and A3W, 4.96 to 12.8 ug/l for Ponds A7 and A14, 4.96 to 19.7 ug/l for Pond A16, 3.0 to 5.6 ug/l for Coyote Creek, and 1.8 to 2.9 ug/l for bay water. Based on these data coupled with mixture estimates, the concentration of dissolved nickel was predicted for each segment of the South Bay in the vicinity of the Alviso Unit under existing and initial release conditions for an eight week period, April 1 to May 26. These predictions were made under both worst-case conditions (i.e., maximum Ni concentrations for bay, river, and all ponds) and average-case conditions (i.e., mean Ni concentrations for bay and river and maximum concentration for all ponds).

The predicted concentrations of dissolved nickel in South S.F. Bay for each of the eight weeks (i.e., April 1 – May 26) are presented in Appendix C, along with the data used in making these predictions. Table 11 summarizes predictions for two of the eight weeks – during the third week of April when dissolved nickel concentrations in South Bay are predicted to be the highest and during the last week in May when the high salinity water has been almost completely pushed out of the contributing ponds and the dissolved nickel concentrations in South Bay are predicted to be the lowest. Predictions for these two weeks of the Initial Release Period are illustrated in Figures 11 and 12. These figures provide a comparison between existing and initial release conditions and illustrate where, if at all, the water quality objective for dissolved nickel of 11.9 ug/l is exceeded. Based on these predictions, the discharges from the Alviso Unit ponds at maximum nickel concentrations are not predicted to cause an exceedence of the nickel water quality objective in any segment of South S.F. Bay at any time during the Initial Release Period and, therefore, are not expected to pose a threat to the aquatic community in that section of the bay.

8. EVALUATION OF NICKEL DISCHARGED FROM BAUMBERG PONDS

For waters north of the Dumbarton Bridge, which includes waters into which the Baumberg discharges will enter, the applicable water quality objective is 7.1 ug/l total recoverable nickel, as specified in the S.F. Bay Basin Plan (SFRWQCB 1995). As indicated in Table 6, it is estimated that, under certain worst-case conditions, the water discharged from some of the Baumberg salt ponds during the Initial Stewardship Period may contain total concentrations of nickel that will exceed this objective. Exceedences are predicted to occur in all discharges during both the Continuous Circulation Period and the Initial Release Period. During continuous circulation, the total nickel concentrations in all discharges are estimated to range from 5.83 to11.8 ug/l. During the Initial Release Period (based on discharges with salinities similar to those that occurred in 2002), the maximum total nickel concentration in all discharges is estimated to be 11.8 ug/l and the minimum concentration will vary between discharges in a range from 5.83 to 8.42 ug/l. During the Initial Release Period (based on discharges with proposed maximum salinities), the range of total nickel concentrations will vary somewhat between discharges (i.e., Ponds 2 and 10 from 7.09 to 15.7 ug/l, Pond 2C from 7.09 to 18.1 ug/l, and Ponds 8A and 6A from 7.09 to 21.8 ug/l).

Three receiving water bodies could potentially be impacted by the discharge, from the Baumberg Unit, of pond water containing concentrations of total nickel in excess of the water quality objective. These are Old Alameda Creek (which will receive Pond 8A discharge), Alameda Flood Control Channel (which will receive Pond 2C discharge), and South Bay proper (which will receive discharges from all the Baumberg Unit ponds). To evaluate how pond discharges might impact these waterbodies, the same four step procedure described in Section 7 was performed with the exception that total nickel concentrations were used rather than dissolved nickel concentrations. The results of these evaluations are described below.

Alameda Flood Control Channel – Initial Release (Proposed Maximum Salinity) – The segmentation of Alameda Flood Control Channel (AFCC) is illustrated in Figure 4. The primary water types that would be found in these segments are bay water and Alameda Creek water under existing conditions and bay water, Alameda Creek water, and Ponds 2C and 2 discharges under initial release conditions. As indicated in Tables 6 and 12, the range of concentrations of total nickel in each of these water types during April and May (when initial release is expected to occur) are 7.09 to 15.7 ug/l for Pond 2, 7.09 to 18.1 ug/l for Pond 2C, 2 ug/l for Alameda Creek, and 4.5 to 8.4 ug/l for bay water. Based on these data coupled with mixture estimates, the concentration of total nickel was predicted for each segment of AFCC under existing and initial release conditions for an eight week period, April 1 to May 26. These predictions were made under both worst-case conditions (i.e., maximum Ni concentrations for bay, river, and Ponds 2 and 2C) and average-case conditions (i.e., mean Ni concentrations for bay and river and maximum concentration for Ponds 2 and 2C).

The predicted concentrations of total nickel in the AFCC for each of the eight weeks (i.e., April 1 – May 26) are presented in Appendix D, along with the data used in making these predictions. Table 13 summarizes predictions for two of the eight weeks – during the first week of May when total nickel concentrations in the AFCC are predicted to be the highest and during the last week in May when the high salinity water has been almost completely pushed out of Ponds 2C & 2 and the total nickel concentrations in the AFCC are predicted to be the lowest. Predictions for these two weeks of the Initial Release Period are illustrated in Figures 13 and 14. These figures provide a comparison between existing and initial release conditions and illustrate where, if at all, the water quality objective for total nickel of 7.1 ug/l is exceeded. Based on these predictions, the discharge from Ponds 2C and 2 at maximum nickel concentrations is predicted to slightly exacerbate non-compliance with the nickel water quality objective. However, the geographical extent and magnitude of the exceedences will be almost eliminated by the end of the initial release period.

If receiving waterbody nickel concentrations were at mean values, all segments of the AFCC are predicted to meet the nickel water quality objective under existing conditions. On the other hand, under initial circulation conditions, the discharge of saline pond water from Ponds 2C and 2 would cause the concentrations of total nickel to increase in the AFCC, resulting in slight exceedences of the objective in three AFCC segments. These exceedences would be expected to be short-lived, however, with compliance with the nickel objective being re-established in all AFCC segments at the end of the initial release period. Due to the small magnitude and short duration of the increases in total nickel concentrations, it is not expected that the aquatic community in the AFCC would be adversely impacted under these conditions.

If receiving waterbody nickel concentrations were at maximum observed values, exceedences of the nickel water quality objective are predicted in three segments of the AFCC under existing conditions during the entire eight weeks of the Initial Release Period. The discharges from Ponds 2C and 2 are predicted to increase nickel concentrations in 7 of the 8 AFCC segments during the first week in May and would increase the number of segments that will be out of compliance (i.e., from three to four). At the end of the initial release period, compliance would be re-established in one of these segments. The remaining three segments would remain slightly out of compliance, but would have total nickel concentrations that were quite similar to those predicted to occur under existing conditions. These slight increases in total nickel concentrations are not expected to pose any additional threat to the aquatic community in the AFCC.

Alameda Flood Control Channel – Initial Release (2002 Salinity) – The segmentation of AFCC and the contributing water types are the same as above. As indicated in Tables 6 and 12, under this discharge scenario, the range of concentrations of total nickel in each of the contributing water types during April and May (when initial release is expected to occur) are 8.42 to 11.8 ug/l for Ponds 2C and 2, 2 ug/l for Alameda Creek, and 4.5 to 8.4 ug/l for bay water. Based on these data coupled with mixture estimates, the concentration of total nickel was predicted for each segment of AFCC under existing and initial release conditions for an eight week period, April 1 to May 26. These predictions were made under both worst-case conditions (i.e., maximum Ni concentrations for bay, river, and Ponds 2 and 2C) and average-case conditions (i.e., mean Ni concentrations for bay and river and maximum concentration for Ponds 2 and 2C).

The predicted concentrations of total nickel in the AFCC for each of the eight weeks (i.e., April 1 – May 26) are presented in Appendix E, along with the data used in making these predictions. Table 14 summarizes predictions for two of the eight weeks – during the first week of May when total nickel concentrations in the AFCC are predicted to be the highest and during the last week in May when the high salinity water has been almost completely pushed out of Ponds 2C & 2 and the total nickel concentrations in the AFCC are predicted to be the lowest. Predictions for these two weeks of the Initial Release Period are illustrated in Figures 15 and 16. These figures provide a comparison between existing and initial release conditions and illustrate where, if at all, the water quality objective for total nickel of 7.1 ug/l is exceeded. Based on these predictions, the discharge from Ponds 2C and 2 at maximum nickel concentrations is predicted to slightly increase the total nickel concentrations in most segments of the AFCC, but does not affect compliance with the nickel water quality objective.

If receiving waterbody nickel concentrations were at mean values, all segments of the AFCC are predicted to meet the nickel water quality objective under both existing conditions and initial release conditions.

If receiving waterbody nickel concentrations were at maximum observed values, exceedences of the nickel water quality objective are predicted in three segments of the AFCC under existing conditions. The discharges from Ponds 2C and 2 are predicted to increase nickel concentrations in 7 of the 8 AFCC segments, but would not increase the number of segments that will be out of compliance. Throughout the Initial Release Period, the three segments would remain slightly out of compliance, but would have total nickel concentrations that were quite similar to those predicted to occur under existing conditions. These very slight increases in total nickel concentrations are not expected to pose any additional threat to the aquatic community in the AFCC.

Alameda Flood Control Channel – Continuous Circulation – The segmentation of AFCC and the contributing water types are the same as above. As indicated in Tables 6 and 12, under this discharge scenario, the range of concentrations of total nickel in each of the contributing water types during May and September (representative early spring and late summer periods during continuous circulation) are 5.83 to 11.8 ug/l for Ponds 2C and 2, 2 ug/l for Alameda Creek, and 4.5 to 8.4 ug/l for bay water. Based on these data coupled with mixture estimates, the concentration of total nickel was predicted for each segment of the AFCC under existing and continuous circulation conditions for the spring and fall periods. These predictions were made under both worst-case conditions (i.e., maximum Ni concentrations for bay, river, and Ponds 2 and 2C) and average-case conditions (i.e., mean Ni concentrations for bay and river and maximum concentration for Ponds 2 and 2C).

The predicted concentrations of total nickel in the AFCC for eight weeks in the spring (i.e., April 1 – May 26) and four weeks in the fall (i.e., September 1-28) are presented in Appendix F, along with the data used in making these predictions. Predictions for two representative weeks are summarized in Table 15 and illustrated in Figures 17 and 18. The figures provide a comparison between existing and continuous circulation conditions and illustrate where, if at all, the water quality objective for total nickel of 7.1 ug/l is exceeded. Based on these predictions, the discharge from Ponds 2C and 2 at maximum nickel concentrations is predicted to slightly exacerbate non-compliance with the nickel water quality objective.

If receiving waterbody nickel concentrations were at mean values, all segments of the AFCC are predicted to meet the nickel water quality objective under existing conditions. However, in May, the discharges from Ponds 2C and 2 are predicted to increase nickel concentrations in 7 of the 8 AFCC segments and would cause three of segments to be out of compliance. In September, the discharges from Ponds 2C and 2 are predicted to increase nickel concentrations in all 8 AFCC segments and would cause five segments to be out of compliance. In both months, the increase in total nickel concentrations in the various segments of the AFCC are predicted to increase by approximately 1 ug/l or less due to the discharges from Ponds 2C and 2. These small increases in total nickel concentrations are not expected to pose a significant additional threat to the aquatic community in the AFCC.

If receiving waterbody nickel concentrations were at maximum observed values, exceedences of the nickel water quality objective are predicted in several segments of the AFCC under existing conditions. In May, the discharges from Ponds 2C and 2 are predicted to increase nickel concentrations in 7 of the 8 AFCC segments, but would not increase the number of segments that will be out of compliance (i.e., four segments are out of compliance under both existing and continuous circulation conditions). In September, the discharges from Ponds 2C and 2 are predicted to increase nickel concentrations in all 8 AFCC segments, but would not increase the number of segments that will be out of compliance (i.e., five segments are out of compliance under both existing and continuous circulation conditions). In both months, the increase in total nickel concentrations in the various segments of the AFCC are predicted to increase by less than

1 ug/l due to the discharges from Ponds 2C and 2. These small increases in total nickel concentrations are not expected to pose a significant additional threat to the aquatic community in the AFCC.

South Bay Proper – Initial Release (Proposed Maximum Salinity) – The segmentation of South Bay in the vicinity of the Baumberg Unit is illustrated in Figure 3. The primary water types that would be found in these segments are bay water and Alameda Flood Control Channel water under existing conditions and bay water, Alameda Flood Control Channel water, and Ponds 2, 2C, 8A, 6A, and 10 discharges under initial release conditions. As indicated in Tables 6 and 12, the range of concentrations of total nickel in each of these water types during April and May (when initial release is expected to occur) are 7.09 to 15.7 ug/l for Ponds 2 and 10, 7.09 to 18.1 ug/l for Pond 2C, 7.09 to 21.8 ug/l for Ponds 8A and 6A, 2 ug/l for the AFCC, and 4.5 to 8.4 ug/l for bay water. Based on these data coupled with mixture estimates, the concentration of total nickel was predicted for each segment of the South Bay in the vicinity of the Baumberg Unit under existing and initial release conditions for an eight week period, April 1 to May 26. These predictions were made under both worst-case conditions (i.e., maximum Ni concentrations for bay, river, and all ponds) and average-case conditions (i.e., mean Ni concentrations for bay and river and maximum concentration for all ponds).

The predicted concentrations of total nickel in S.F. Bay near the Baumberg unit for each of the eight weeks (i.e., April 1 – May 26) are presented in Appendix G, along with the data used in making these predictions. Table 16 summarizes predictions for two of the eight weeks – during the second week of May when total nickel concentrations in this section of S.F. Bay are predicted to be the highest and during the last week in May when the high salinity water has been almost completely pushed out of the contributing ponds and the total nickel concentrations in this section of the bay are predicted to be the lowest. Predictions for these two weeks of the Initial Release Period are illustrated in Figures 19 and 20. These figures provide a comparison between existing and initial release conditions and illustrate where, if at all, the water quality objective for total nickel of 7.1 ug/l is exceeded. Based on these predictions, the discharges from all of the Baumberg Ponds at maximum nickel concentrations result in only slight increases in total nickel concentrations in either bay segment. When ambient bay and AFCC total nickel concentrations are at mean levels, there are no predicted exceedences of the nickel objective under either existing or initial release conditions. On the other hand, when ambient bay concentrations are at maximum observed levels, similar patterns of exceedences of the nickel objective occur under both existing and initial release conditions. The discharge from the Baumberg Ponds would cause only a very slight increase in the ambient concentrations and would, consequently, have no impact on compliance and would not be expected to pose an additional threat to aquatic life in that section of the bay.

South Bay Proper – Initial Release (2002 Salinity) – The segmentation of South Bay and the contributing water types are the same as above. As indicated in Tables 6 and 12, under this discharge scenario, the range of concentrations of total nickel in each of these water types during April and May (when initial release is expected to occur) are 8.42 to 11.8 ug/l for Ponds 2 and 2C, 5.83 to 11.8 ug/l for Pond 10, 7.09 to 11.8 ug/l for Pond 8A, 2 ug/l for the AFCC, and 4.5 to 8.4 ug/l for bay water. Based on these data coupled with mixture estimates, the concentration of total nickel was predicted for each segment of the South Bay in the vicinity of the Baumberg

Unit under existing and initial release conditions for an eight week period, April 1 to May 26. These predictions were made under both worst-case conditions (i.e., maximum Ni concentrations for bay, river, and all ponds) and average-case conditions (i.e., mean Ni concentrations for bay and river and maximum concentration for all ponds).

The predicted concentrations of total nickel in S.F. Bay near the Baumberg unit for each of the eight weeks (i.e., April 1 – May 26) are presented in Appendix H, along with the data used in making these predictions. Table 17 summarizes predictions for two of the eight weeks – during the second week of May when total nickel concentrations in this section of S.F. Bay are predicted to be the highest and during the last week in May when the high salinity water has been almost completely pushed out of the contributing ponds and the total nickel concentrations in this section of the bay are predicted to be the lowest. Predictions for these two weeks of the Initial Release Period are illustrated in Figures 21 and 22. These figures provide a comparison between existing and initial release conditions and illustrate where, if at all, the water quality objective for total nickel of 7.1 ug/l is exceeded. Based on these predictions, the discharges from all of the Baumberg Ponds at maximum nickel concentrations result in negligible increases in total nickel concentrations in either South Bay segment. When ambient bay and AFCC total nickel concentrations are at mean levels, there are no predicted exceedences of the nickel objective under either existing or initial release conditions. On the other hand, when ambient bay concentrations are at maximum observed levels, a similar pattern of exceedences of the nickel objective occur under both existing and initial release conditions. The discharge from the Baumberg Ponds would cause only a negligible increase in the ambient concentrations and would, consequently, have no impact on compliance and would not be expected to pose an additional threat to aquatic life in that section of the bay.

South Bay Proper – Continuous Circulation – The segmentation of South Bay and the contributing water types are the same as above. As indicated in Tables 6 and 12, under this discharge scenario, the range of concentrations of total nickel in each of these water types during May (representative spring conditions) are 5.83 to 11.8 ug/l for all Baumberg Ponds, 2 ug/l for Alameda Flood Control Channel, and 4.5 to 8.4 ug/l for bay water. In September (representative late summer conditions) the range of concentrations are predicted to be 5.83 to 11.8 ug/l for all Baumberg Ponds, 2 ug/l for the AFCC, and 4.3 to 9.7 ug/l for bay water. Based on these data coupled with mixture estimates, the concentration of total nickel was predicted for each segment of the South Bay in the vicinity of the Baumberg Unit under existing and continuous circulation conditions. These predictions were made under both worst-case conditions (i.e., maximum Ni concentrations for bay, river, and all ponds) and average-case conditions (i.e., mean Ni concentrations for bay and river and maximum concentration for all ponds).

The predicted concentrations of total nickel in S.F. Bay near the Baumberg Unit for each of the eight weeks in the spring (April 1 to May 26) and four weeks in the fall (September 1-28) are presented in Appendix I, along with the data used in making these predictions. Table 18 summarizes predictions for two of the twelve weeks – during the first week of May and the second week of September. Predictions for these two weeks of the Continuous Circulation Period are illustrated in Figures 23 and 24. These figures provide a comparison between existing and initial release conditions and illustrate where, if at all, the water quality objective for total nickel of 7.1 ug/l is exceeded. Based on these predictions, the discharges from all of the Baumberg

Ponds at maximum nickel concentrations result in negligible increases in total nickel concentrations in either South Bay segment. When ambient bay and AFCC total nickel concentrations are at mean levels, there are no predicted exceedences of the nickel objective under either existing or continuous circulation conditions in either May or September. On the other hand, when ambient bay concentrations are at maximum observed levels, very similar patterns of exceedences of the nickel objective would occur under both existing and continuous circulation conditions in both May and September. The discharge from the Baumberg Ponds would not cause a significant increase in the ambient concentrations during either May or September and would have no effect on compliance with the nickel objective. In addition, these very small increases in total nickel concentrations would not be expected to pose an additional threat to the aquatic community in that section of the bay.

9. EVALUATION OF MERCURY DISCHARGED FROM BAUMBERG PONDS

For waters north of the Dumbarton Bridge, which includes waters into which the Baumberg Ponds will discharge, the applicable water quality objective is 25 ng/l total recoverable mercury (as specified in the S.F. Bay Basin Plan). As indicated in Table 7, it is estimated that, under certain worst-case conditions, the water discharged from some of the Baumberg salt ponds during the Initial Stewardship Period may contain total concentrations of mercury that will exceed this objective. Exceedences are predicted to occur in all discharges during the Initial Release Period if the salinities of the discharges are at their proposed maximum values and in Old Alameda Creek if the salinity of the 8A discharge is either at its proposed maximum value or at levels observed in 2002. During the Initial Release Period (based on discharges with proposed maximum salinities), the upper end of the range of total mercury concentrations in all discharges will exceed the objective, but the actual predicted value will vary somewhat between discharges (i.e., Ponds 2 and 10 from 3.37 to 32 ng/l, Pond 2c from 3.37 to 44.5 ng/l, and Ponds 8A and 6A from 3.37 to 49.7 ng/l).

Three receiving water bodies could potentially be impacted by the discharge of water from Baumberg Unit Ponds containing concentrations of total mercury in excess of the water quality objective. These are Old Alameda Creek (which will receive Pond 8A discharge), Alameda Flood Control Channel (which will receive 2C discharge), and South Bay proper (which will receive discharge from all of the Baumberg Unit ponds). To evaluate the impact that the discharges might have on these waterbodies, the same four step procedure described in Section 7 was performed with the exception that total mercury concentrations were used rather than dissolved nickel concentrations. The results of these evaluations are described below.

Alameda Flood Control Channel – Initial Release (Proposed Maximum Salinity) – The segmentation of Alameda Flood Control Channel (AFCC) is illustrated in Figure 4. The primary water types that would be found in these segments are bay water and Alameda Creek water under existing conditions and bay water, Alameda Creek water, and Ponds 2C and 2 discharges under initial release conditions. As indicated in Tables 7 and 19, the range of concentrations of total mercury in each of these water types during April and May (when initial release is expected to occur) are 3.37 to 32 ng/l for Ponds 2 and 10, 3.37 to 44.5 ng/l for Pond 2C, 16.3 to 31.4 ng/l for Alameda Creek, and 5.4 to 35.9 ng/l for bay water. Based on these data coupled with mixture estimates, the concentration of total mercury was predicted for each segment of AFCC under existing and initial release conditions for an eight week period, April 1 to May 26. These predictions were made under both worst-case conditions (i.e., maximum Hg concentrations for bay, river, and Ponds 2 and 2C) and average-case conditions (i.e., mean Hg concentrations for bay and river and maximum concentration for Ponds 2 and 2C).

The predicted concentrations of total mercury in the AFCC for each of the eight weeks are presented in Appendix J, along with the data used in making these predictions. Table 20 summarizes predictions for two of the eight weeks – during the second week of April when total mercury concentrations in the AFCC are predicted to be the highest and during the last week in May when the high salinity water has been almost completely pushed out of Ponds 2C & 2 and the total mercury concentrations in the AFCC are predicted to be the lowest. Predictions for these two weeks of the Initial Release Period are illustrated in Figures 25 and 26. These figures provide a comparison between existing and initial release conditions and illustrate where, if at all, the water quality objective for total mercury of 25 ng/l is exceeded. Based on these predictions, the discharge from Ponds 2C and 2 at maximum mercury concentrations is predicted to very slightly exacerbate non-compliance with the mercury water quality objective. However, the geographical extent and magnitude of the exceedences will be eliminated by the end of the Initial Release Period.

If receiving waterbody mercury concentrations were at mean values, all segments of the AFCC are predicted to meet the nickel water quality objective under existing conditions. Under initial release conditions, the discharge of saline pond water from Ponds 2C and 2 would cause the concentrations of total mercury to increase in the AFCC, resulting in essentially reaching the objective in one AFCC segment. This minor exceedence of the objective would be expected to be short-lived, however, with clear compliance with the mercury objective being re-established in all AFCC segments at the end of the Initial Release Period. Due to the small magnitude and short duration of the increases in total mercury concentrations, it is not expected that the aquatic community in the AFCC would be adversely impacted under these conditions.

If receiving waterbody mercury concentrations were at maximum observed values, it is predicted that all segments of the AFCC would exceed the mercury water quality objective under existing conditions. Initial release from the ponds would have negligible effect on mercury concentrations in the AFCC and, consequently, on compliance with the mercury objective. The discharges from Ponds 2C and 2 are predicted to slightly increase mercury concentrations in 7 of the 8 AFCC segments in the second week of the initial release, but actually significantly decrease mercury concentrations at the end of the Initial Release Period. It is not expected that discharges under these conditions will adversely impact aquatic life in the AFCC.

South Bay Proper – Initial Release (Proposed Maximum Salinity) – The segmentation of South Bay in the vicinity of the Baumberg Unit is illustrated in Figure 3. The primary water types that would be found in these segments are bay water and Alameda Flood Control Channel under existing conditions and bay water, Alameda Flood Control Channel water, and Ponds 2, 2C, 8A, 6A, and 10 discharges under initial release conditions. As indicated in Tables 7 and 19, the range of concentrations of total mercury in each of these water types during April and May (when initial release is expected to occur) are 3.37 to 32 ng/l for Ponds 2 and 10, 3.37 to 44.5 ng/l for Pond 2C, 3.37 to 49.7 ng/l for Ponds 8A and 6A, 16.3 to 31.4 ng/l for Alameda Flood

Control Channel, and 5.4 to 35.9 ng/l for bay water. Based on these data coupled with mixture estimates, the concentration of total mercury was predicted for each segment of the South Bay in the vicinity of the Baumberg Unit under existing and initial release conditions for an eight week period, April 1 to May 26. These predictions were made under both worst-case conditions (i.e., maximum Hg concentrations for bay, river, and all ponds) and average-case conditions (i.e., mean Hg concentrations for bay and river and maximum concentration for all ponds).

The predicted concentrations of total mercury in the South Bay near the Baumberg Unit for each of the eight weeks (i.e., April 1 – May 26) are presented in Appendix K, along with the data used in making these predictions. Table 21 summarizes predictions for two of the eight weeks – during the second week of April when total mercury concentrations in the AFCC are predicted to be the highest and during the last week in May when the high salinity water has been almost completely pushed out of Ponds 2C & 2 and the total mercury concentrations in the AFCC are predicted to be the lowest. Predictions for these two weeks of the Initial Release Period are illustrated in Figures 27 and 28. These figures provide a comparison between existing and initial release conditions and illustrate where, if at all, the water quality objective for total mercury of 25 ng/l is exceeded. Based on these predictions, the discharge from Ponds 2C and 2 at maximum mercury concentrations is predicted to result in negligible changes in total mercury concentrations in either South Bay segment. When ambient bay and AFCC total mercury concentrations are at mean levels, there are no predicted exceedences of the mercury objective under either existing or initial release conditions. On the other hand, when ambient bay concentrations are at maximum observed levels, exceedences of the mercury objective occur under existing conditions. The discharge from the Baumberg Ponds during the Initial Release Period is predicted to actually cause a slight decrease in the ambient concentrations and would, consequently, have no impact on compliance. Similarly, these discharges would not be expected to adversely impact aquatic life in this section of the bay.

10. SUMMARY AND CONCLUSIONS

Saline waters which will be circulated to South San Francisco Bay and its tributaries from the salt ponds during the Initial Stewardship Period will contain measurable concentrations of heavy metals. Using analytical data collected from a sub-set of these ponds, estimates were made of the range of concentrations that would likely occur in the proposed discharges during the initial release and the continuous circulation phases of the Interim Stewardship Period. Comparisons were made between these estimated discharge concentrations and applicable water quality objectives. The results of these comparisons clearly indicate that, for every proposed discharge, during both the initial release and continuous circulation phases, the maximum predicted concentrations of arsenic, cadmium, chromium, copper, lead, selenium, silver, and zinc will not exceed the applicable water quality objectives. Therefore, for all the proposed discharges, these metals are not considered a threat to aquatic life in the receiving waters.

On the other hand, based on the aforementioned comparisons, both nickel and mercury were predicted to exceed their applicable water quality objectives under some circumstances:

- Dissolved nickel concentrations might exceed objectives applicable to discharges from ponds in the Alviso Unit during the Initial Release Period.

- Total nickel concentrations might exceed objectives applicable to discharges from the Baumberg and Westside Units during both the Initial Release Period and the Continuous Circulation Period.

- Total mercury concentrations might exceed objectives applicable to discharges from the Baumberg and Westside Units during the Initial Release Period.

In order to determine the significance of these potential exceedences, evaluations were performed to estimate how these discharges would alter concentrations in the receiving waters and how these alterations would impact aquatic life. The results of these evaluations are summarized below.

Dissolved Nickel Discharged from Ponds in the Alviso Unit – The initial comparisons indicated that dissolved nickel concentrations in several of the discharges from the Alviso Unit might exceed the applicable water quality objective for waterbodies south of the Dumbarton Bridge of 11.9 ug/l dissolved nickel. These exceedences are predicted to occur only when ponds are discharging at their maximum proposed salinities and would be limited to the Initial Release Period. The discharges that might exceed water quality objectives (from ponds A7, A14, and A16) have the potential to impact waters in Alviso Slough, Coyote Creek, and portions of South Bay. The potential for impacts on each of these waterbodies is evaluated below.

> **Nickel discharged into Alviso Slough** – One of the proposed discharges that might exceed the nickel objective of 11.9 ug/l is from Pond A7 into Alviso Slough. These exceedences would be limited to the Initial Release Period and were only predicted to occur if A7 was discharging at its maximum proposed salinity. An in-depth evaluation indicated that after initial mixing, there would be no predicted exceedences of the nickel objective in Alviso Slough and, consequently, no expected impact to aquatic life.
>
> **Nickel discharged into Coyote Creek** – Another of the proposed discharges that might exceed the nickel objective of 11.9 ug/l is from Ponds A14 and A16 into Coyote Creek and Artesian Slough. These exceedences would be limited to the Initial Release Period and were only predicted to occur if A14 and A16 were discharging at their maximum proposed salinities. An in-depth evaluation indicated that after initial mixing, there would be no predicted exceedences of the nickel objective in either Coyote Creek or Artesian Slough and, consequently, no expected impact to aquatic life.
>
> **Nickel discharged into South S.F. Bay near the Alviso Unit** – All of the discharges in the Alviso Unit eventually enter South S.F. Bay. Three of these (A7, A14, and A16) are predicted to exceed the nickel objective of 11.9 ug/l. These exceedences would be limited to the Initial Release Period and were only predicted to occur if the subject ponds were discharging at their maximum proposed salinities. An in-depth evaluation indicated that after initial mixing, there would be no predicted exceedences of the nickel objective in South S.F. Bay and, consequently, no expected impact to aquatic life.

Total Mercury Discharged from Ponds in the Baumberg Unit – The initial comparisons indicated that total mercury concentrations in all of the discharges from the Baumberg Unit might exceed the applicable water quality objective for waterbodies north of the Dumbarton Bridge of 25 ng/l total mercury. These exceedences were predicted to occur only when ponds are discharging at their maximum proposed salinities and would be limited to the Initial Release Period. Under these conditions, these discharges have the potential to impact waters in the Alameda Flood Control (AFCC), Old Alameda Creek, and portions of South Bay. The potential for impacts on AFCC and the South Bay are evaluated below.

> **Mercury discharged into Alameda Flood Control Channel –** Two of the proposed discharges that might exceed the mercury objective of 25 ng/l are Ponds 2 and 2C. The Pond 2C discharge will flow directly into the AFCC and the Pond 2 discharge will be circulated into the AFCC by tidal action. It is predicted that the exceedences of the mercury objective in these discharges will be limited to the Initial Release Period and will only occur if the discharges are at their maximum proposed salinity. An in-depth evaluation indicated that, after initial mixing, these discharges would have minimal impact on compliance with the mercury water quality objective in the AFCC. When the waters in the AFCC contain average concentrations of total mercury, the discharge from Ponds 2 and 2C, would at worst raise the ambient concentrations in the AFCC by approximately 10% and would result in equaling the objective in 3 to 4 kilometers of the channel. This condition would last for less than 8 weeks; disappearing at the end of the Initial Release Period. When the waters in the AFCC contain maximum concentrations of total mercury, the discharge from Ponds 2 and 2C, would have essentially no effect. Under existing conditions, the mercury objective would be exceeded throughout the creek by between 7 and 10 ng/l and the input from the ponds would increase these concentrations by less than 1 ng/l. Any increases due to the pond discharges would last for less than 8 weeks; disappearing at the end of the Initial Release Period.

> **Mercury discharged into South S.F. Bay near the Baumberg Unit –** During the Initial Release Period, all of the discharges in the Baumberg Unit have the potential to exceed the mercury of objective of 25 ng/l and all of these discharges eventually enter South S.F. Bay. It is predicted that these exceedences would occur during the Initial Release Period only if the Baumberg ponds were discharging at their maximum proposed salinities. An in-depth evaluation indicated that, after initial mixing, these discharges would have no impact on compliance with the mercury water quality objective in the South Bay near the Baumberg Unit. When the waters in the South Bay contain average concentrations of total mercury, the discharges from the Baumberg ponds would increase total mercury in ambient bay water by less 1 ng/l and would not cause an exceedence of the mercury objective. When the waters of South Bay contain maximum concentrations of total mercury, the discharge from the Baumberg ponds would have essentially no effect. Under existing conditions, the mercury objective would be exceeded throughout the South Bay by approximately 11 ng/l and the input from the ponds would actually decrease these concentrations.

Total Nickel Discharged from Ponds in the Baumberg Unit – The initial comparisons indicated that total nickel concentrations in all of the discharges from the Baumberg Unit might exceed the applicable water quality objective for waterbodies north of the Dumbarton Bridge of 7.1 ug/l total nickel. These exceedences have the potential to occur during all phases of the Initial Stewardship Period and over a wide range of discharge salinities. During both the Initial Release and Continuous Circulation Periods, these discharges have the potential to impact waters in the Alameda Flood Control (AFCC), Old Alameda Creek, and portions of South Bay. The potential for impacts on AFCC and the South Bay are evaluated below.

Nickel discharged into Alameda Flood Control Channel – Two of the proposed discharges that might exceed the nickel objective of 7.1 ug/l are Ponds 2 and 2C. The Pond 2C discharge will flow directly into the AFCC and the Pond 2 discharge will be circulated into the AFCC by tidal action. It is predicted that the exceedences of the nickel objective in these discharges might occur during both the Initial Release and Continuous Circulation Periods and might occur regardless of the salinity of the discharges. An in-depth evaluation indicated that, after initial mixing, these discharges would have limited impacts on compliance with the nickel water quality objective in the AFCC.

During the Initial Release Period, compliance with the nickel objective in the AFCC would depend upon both the ambient concentrations of nickel in the AFCC and the salinity of the discharges. If the ambient waters contain average concentrations of nickel, impacts on compliance of the nickel objective would be minimal. With average ambient nickel concentrations and discharge salinities at 2002 levels, there are no predicted exceedences of the nickel objective anywhere in the AFCC. With average ambient nickel concentrations and discharge salinities at their proposed maximum levels, exceedences of the objective are predicted for 3 kilometers of the AFCC. However, these exceedences would disappear at the end of the Initial Release Period.

During the Initial Release Period, if the ambient waters contain maximum concentrations of nickel, predicted impacts on compliance with the nickel objective would be somewhat greater, but still relatively limited in magnitude and scope. Under such conditions, it is predicted that, even without any discharges from the Baumberg Ponds, 3 kilometers of the AFCC would exceed the nickel objective. With the addition of the discharges at salinities near those observed in 2002, total mercury in most segments of the AFCC would increase slightly (i.e., generally by less than 1 ug/l), but exceedences of the objective are predicted to remain at 3 kilometers of the AFCC. With the addition of the discharges at salinities near the proposed maximum values, exceedences of the objective (by up to 3 ug/l) are predicted to increase to 4 kilometers of the AFCC. However, at the end of the Initial Release Period, the area of the AFCC exceeding the nickel objective would be reduced to 3 km; the same area that is predicted to be out of compliance under existing conditions.

During the Continuous Circulation Period, compliance with the nickel objective in the AFCC would depend upon the ambient concentrations of nickel in the AFCC. If the ambient waters contain average concentrations of nickel, it is predicted that after initial mixing, three of the AFCC segments would slightly exceed the nickel objective in May and five would slightly exceed the objective in September. If the ambient waters contain maximum concentrations of nickel, it is predicted that even without any discharge from the Baumberg ponds, the nickel objective would be exceeded in 4 kilometers of the AFCC in May and 5 kilometers in September. With the addition of the discharges, total nickel concentrations in all segments of the AFCC are predicted to increase by less than 1 ug/l, but the number of segments of the AFCC exceeding the nickel would not increase.

Nickel discharged into South S.F. Bay near the Baumberg Unit – During the Initial Release Period, all of the discharges in the Baumberg Unit have the potential to exceed the nickel of objective of 7.1 ug/l and all of these discharges eventually enter South S.F. Bay. It is predicted that the exceedences of the nickel objective in these discharges might occur during both the Initial Release and Continuous Circulation Periods and might occur regardless of the salinity of the discharges. An in-depth evaluation indicated that, after initial mixing, these discharges would have no effect on compliance with the nickel water quality objective in the South Bay in the vicinity of the Baumberg Unit. When the waters in the South Bay contain average concentrations of total nickel, the discharges from the Baumberg ponds would increase total nickel in ambient bay water by 0.5 ug/l or less and would not cause an exceedence of the nickel objective. When the waters of South Bay contain maximum concentrations of total nickel, the discharge from the Baumberg ponds would have essentially no effect on compliance with the nickel objective. Under such conditions, the nickel objective would be exceeded throughout the South Bay by 1 to 3 ug/l and the input from the ponds would not cause measurable changes in these concentrations.

11. LITERATURE CITED

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TABLE 1. APPLICABLE WATER QUALITY OBJECTIVES FOR RECEIVING WATERS IN VICINITY OF POND DISCHARGES

Metal	Objective for South of Dumbarton Bridge[a] (ug/l)		Objective for North of Dumbarton Bridge[c] (ug/l)	
Arsenic	36	Dissolved	36	Total
Cadmium	9.3	Dissolved	9.3	Total
Chromium	50	Dissolved	50	Total
Copper	6.9[b]	Dissolved	5.3[d]	Dissolved
Lead	8.1	Dissolved	5.6	Total
Mercury	0.050	Total	0.025	Total
Nickel	11.9	Dissolved	7.1	Total
Selenium	5.0	Total	5.0	Total
Silver	1.9	Dissolved	2.3	Total
Zinc	81	Dissolved	58	Total

a - all objectives except for copper and nickel are as stated in the California Toxics Rule (40CFR 131.38)
b - copper and nickel site-specific objectives developed by S.F. Regional Water Quality Control Board
c - all objectives except for copper are as specified in the S.F. Bay Basin Plan 6/95
d - copper site-specific objective being considered by S.F. Regional Water Quality Control Board

Table 2. Measured Metal Concentrations in Water Column Samples Collected from South Bay Salt Ponds on 10/24/02[a]

Pond ID	Salinity (g/L)	Dissolved Concentration Cr (ug/l)	Ni (ug/l)	Cu (ug/l)	Zn IP; AFCC =	As (ug/l)	Total Recoverable Concentration Cr (ug/l)	Ni (ug/l)	Cu (ug/l)	Zn (ug/l)	As (ug/l)
A2W	31.6	1.22	8.05	1.06	1.21	6.27	2.36	11.8[d]	2.15	1.8	6.36
A3W	42	1.22	7.45	1.10	0.65	10.7	0.67	8.42[d]	1.24	0.79	11.9
B2C	54.6	1.24	4.96	1.29	1.18	1.14	0.67	7.09	1.59	1.28	1.0
A15	89.4	1.12	10.8	0.86	1.29	14.0	0.83	14.3[d]	1.37	1.82	15.1
A15 (Dup)	89.8	1.16	10.6	0.89	1.83	14.5	1.07	15.7[d]	1.59	3.07	15.7
A14	92.6	1.35	11.0	0.97	1.15	18.3	1.17	13.5[d]	2.04	3.16	20.1
A16	109	1.27	12.8[c]	1.07	2.25	14.4	1.23	18.1[d]	2.01	3.38	17.1
A18	146	1.35	19.7[c]	1.92	2.88	48.3	1.30	21.8[d]	3.39	4.49	56.2
I-3[b]	194	1.16	10.8	0.57	2.87	3.52	1.47	9.73[d]	2.07	6.77	4.28
I-3B[b]	224	1.47	13.3[c]	2.64	4.02	3.14	1.38	12.3[d]	2.45	7.22	5.18
B9	279	1.34	14.5[c]	2.21	3.80	30.9	1.12	15.1[d]	2.61	4.28	33.1

Pond ID	Salinity (g/L)	Dissolved Concentration Se (ug/l)	Ag (ug/l)	Cd (ug/l)	Hg (ng/l)	Pb (ug/l)	Total Recoverable Concentration Se (ug/l)	Ag (ug/l)	Cd (ug/l)	Hg (ng/l)	Pb (ug/l)
A2W	31.6	0.199	0.012	0.049	1.26	0.264	0.274	0.022	0.063	11.8	0.843
A3W	42	0.128	0.010	0.044	1.26	0.307	0.173	0.015	0.045	4.78	0.324
B2C	54.6	0.055	0.016	0.054	0.36	0.280	0.092	0.013	0.050	3.37	0.392
A15	89.4	0.094	0.021	0.077	1.38	0.313	0.160	0.030	0.054	32.0[e]	0.351
A15 Dup	89.8	0.124	0.027	0.067	1.28	0.330	0.135	0.020	0.054	32.0[e]	0.371
A14		0.111	0.055	0.039	2.21	0.309	0.220	0.063	0.053	44.5[e]	0.395
A16	109	0.141	0.040	0.053	1.40	0.446	0.159	0.150	0.062	39.5[e]	0.619
A18	146	0.224	0.023	0.899[a]	1.14	0.748	0.310	0.045	0.119	49.7[e]	1.37
I-3[b]	194	0.304	0.015	0.096	0.56	0.572	0.295	0.128	0.119	35.6[e]	0.892
I-3B[b]	224	0.142	0.039	0.124	0.69	1.33	0.352	0.044	0.136	41.0[e]	1.15
B9	279	0.140	0.028	0.423	0.41	7.18	0.143	0.416	0.123	30.0[e]	6.48

[a] Possible laboratory contaminination suspected by Frontier Geoscience

a - Samples collected by S.R. Hansen & Associates and Analyzed by Frontier Geoscience in Seattle, Washington
b - Ponds I-3 and I-3B are part of Cargill's Plant 1 unit and are located immediately south of the Dumbarton Bridge.
These ponds are not part of the sale, but would have water quality representative of ponds in the sale with similar salinities.
c - Measured values exceed site-specific WQO for So. Bay of 11.9 ug/l (dissolved Ni); applicable to Alviso Ponds discharge
d - Measured values exceed Basin Plan WQO of 7.1 ug/l (total Ni); applicable to Baumberg and West Bay Ponds discharge
e - Measured values exceed Basin Plan WQO of 25 ng/l (total Hg); applicable to Baumberg and West Bay Ponds discharge

Table 3. Estimated Range of Salinities at Each Discharge Point

Discharge Point	Estimated Range of Salinities at Discharge Point (ppt)		
	Initial Release Period (based on 2002 Data) (first 2 months)	Initial Release Period (Proposed Maximum) (first 2 months)	Continuous Circulation Period
Alviso Unit			
A2W	27 - 31	27 - 65	14 - 44
A3W	28 - 31	27 - 65	14 - 44
A7	27 - 51	26 - 110	12 - 44
A14	36 - 75	36 - 100	20 - 44
A16	44 - 83	29 - 135	15 - 44
A19, A20, A21		29 - 135	15 - 44
Baumberg Unit			
2	30 - 37	30 - 65	18 - 44
11	25 - 35	28 - 65	15 - 44
2C	30 - 37	32 - 100	18 - 44
8A	48- 98	74 - 135	20 - 44
6A		28 - 135	16 - 44
West Bay Unit			
SF-2		28 - 135	16 - 44
5S		28 - 135	16 - 44

Table 4. Estimated Range of Dissolved Metal Concentrations for Each Discharge Point during Initial Release and Continuous Circulation Periods

Discharge Point	Period of Interest	Predicted Salinity Range of Discharge (ppt)	Salinities of Surrogates Considered (ppt)		Estimated Dissolved Concentrations (ug/l) Cr	Ni	Cu	Zn	As	Se	Ag	Cd	Hg (ng/l)	Pb
Alviso Ponds All Ponds	Continuous Circulation	12 - 44	13 - 42[a]	min	0.27	3.1	1.06	0.65	3.38	0.128	0.004	0.044	1.26	0.082
				max	1.22	8.05	2.98	1.83	10.7	0.4	0.012	0.078	1.8	0.307
A2W	Initial Release (based on 2002)	27 - 31	19.6 - 31.6[b]	min	0.27	3.1	1.06	12.1	3.38	0.199	0.0012	0.049	1.26	0.082
				max	1.22	8.05	3	1.9	6.27	0.4	0.004	0.078	1.8	0.264
	Initial Release (Proposed Max)	27 - 65	31.6 - 89.8[c]	min	1.12	4.96	0.86	0.65	1.14	0.055	0.01	0.044	0.36	0.264
				max	1.24	10.8	1.29	1.83	14.5	0.199	0.027	0.077	1.38	0.33
A3W	Initial Release (based on 2002)	28 - 31	19.6 - 31.6[b]	min	0.27	3.1	1.06	12.1	3.38	0.199	0.0012	0.049	1.26	0.082
				max	1.22	8.05	3	1.9	6.27	0.4	0.004	0.078	1.8	0.264
	Initial Release (Proposed Max)	27 - 65	31.6 - 89.8[c]	min	1.12	4.96	0.86	0.65	1.14	0.055	0.01	0.044	0.36	0.264
				max	1.24	10.8	1.29	1.83	14.5	0.199	0.027	0.077	1.38	0.33
A7	Initial Release (based on 2002)	27 - 51	31.6 - 54.6[d]	min	1.22	4.96	1.06	0.65	1.14	0.055	0.01	0.044	0.36	0.264
				max	1.24	7.45	1.29	1.21	10.7	1.99	0.016	0.054	1.26	0.307
	Initial Release (Proposed Max)	26 - 110	31.6 - 109[e]	min	1.12	4.96	0.86	0.65	1.14	0.055	0.01	0.039	0.36	0.264
				max	1.35	12.8[h]	1.29	2.25	18.3	0.199	0.055	0.077	2.21	0.446
A14	Initial Release (based on 2002)	36 - 75	31.6 - 89.8[c]	min	1.12	4.96	0.86	0.65	6.27	0.055	0.01	0.044	0.36	0.264
				max	1.24	10.8	1.29	1.83	14.5	0.199	0.027	0.077	1.38	0.33
	Initial Release (Proposed Max)	36 -100	31.6 - 109[e]	min	1.12	4.96	0.86	0.65	1.14	0.055	0.01	0.039	0.36	0.264
				max	1.35	12.8[h]	1.29	2.25	18.3	0.199	0.055	0.077	2.21	0.446
A16	Initial Release (based on 2002)	44 - 83	42 - 89.8[f]	min	1.12	4.96	0.86	0.65	10.7	0.055	0.01	0.044	0.36	0.28
				max	1.24	10.8	1.29	1.83	14.5	0.128	0.027	0.077	1.38	0.33
	Initial Release (Proposed Max)	29 - 135	31.6 - 146[g]	min	1.12	4.96	0.86	0.65	1.14	0.055	0.01	0.039	0.36	0.264
				max	1.35	19.7[h]	1.92	2.88	48.3	0.224	0.055	0.077	2.21	0.748
A19, A20, A21	Initial Release (Proposed Max)	29 - 135	31.6 - 146[g]	min	1.12	4.96	0.86	0.65	1.14	0.055	0.01	0.039	0.36	0.264
				max	1.35	19.7[h]	1.92	2.88	48.3	0.224	0.055	0.077	2.21	0.748

a = considers average data from RMP 1997-1999 for South Bay Station as well as salt ponds at 31.6 and 42 ppt salinity
b = considers average data from RMP 1997-1999 for South Bay Station as well as salt pond at 31.6 ppt salinity
c = considers data from salt ponds with salinities of 31.6, 42, 54.6, 89.4, & 89.8 ppt
d = considers data from salt ponds with salinities of 31.6, 42, & 54.6 ppt
e = considers data from salt ponds with salinities of 31.6, 42, 54.6, 89.4, 89.8, 92.6, & 109 ppt
f = considers data from salt ponds with salinities of 42, 54.6, 89.4, & 89.8 ppt
g = considers data from salt ponds with salinities of 31.6, 42, 54.6, 89.4, 89.8, 92.6, 109, & 146 ppt
h - Estimated maximum values exceed site-specific WQO for So. Bay of 11.9 ug/l (dissolved Ni); applicable to Alviso Ponds discharge

Table 4 Cont'd. Estimated Range of Dissolved Metal Concentrations for Each Discharge Point during Initial Release and Continuous Circulation Periods

Discharge Point	Period of Interest	Predicted Salinity Range of Discharge (ppt)	Salinities of Surrogates Considered (ppt)		Estimated Dissolved Concentrations (ug/l) Cr	Ni	Cu	Zn	As	Se	Ag	Cd	Hg (ng/l)	Pb
Baumberg Unit All Ponds	Continuous Circulation	15 - 44	15 - 42[a]	min	0.2	2.47	1.06	0.65	3.12	0.128	0.005	0.044	1.26	0.051
				max	1.22	8.05	2.55	1.21	10.7	0.298	0.012	0.065	1.3	0.307
2	Initial Release (based on 2002)	30 - 37	31.6 - 42[b]	min	1.22	7.45	1.06	0.65	6.27	0.128	0.01	0.044	1.26	0.264
				max	1.22	8.05	1.1	1.21	10.7	0.199	0.012	0.049	1.26	0.307
	Initial Release (Proposed Max)	30 - 65	31.6 - 89.8[c]	min	1.12	4.96	0.86	0.65	1.14	0.055	0.01	0.044	0.36	0.264
				max	1.24	10.8	1.29	1.83	14.5	0.199	0.027	0.077	1.38	0.33
11	Initial Release (based on 2002)	25 - 35	20.9 - 42[d]	min	0.19	2.5	1.06	0.65	3.12	0.128	0.005	0.044	1.26	0.051
				max	1.22	8.05	2.6	1.21	10.7	0.3	0.012	0.07	1.3	0.307
	Initial Release (Proposed Max)	28 - 65	31.6 - 89.8[c]	min	1.12	4.96	0.86	0.65	1.14	0.055	0.01	0.044	0.36	0.264
				max	1.24	10.8	1.29	1.83	14.5	0.199	0.027	0.077	1.38	0.33
2C	Initial Release (based on 2002)	30 - 37	31.6 - 42[b]	min	1.22	7.45	10.6	0.65	6.27	0.128	0.01	0.044	1.26	0.264
				max	1.22	8.05	1.1	1.21	10.7	0.199	0.012	0.049	1.26	0.307
	Initial Release (Proposed Max)	32 - 100	31.6 - 109[e]	min	1.12	4.96	0.86	0.65	1.14	0.055	0.01	0.039	0.36	0.264
				max	1.35	12.8	1.29	2.25	18.3	0.199	0.055	0.077	2.21	0.446
8A	Initial Release (based on 2002)	48 - 98	42 - 109[f]	min	1.12	4.96	0.86	0.65	1.14	0.055	0.01	0.039	0.36	0.28
				max	1.35	12.8	1.29	2.25	18.3	0.141	0.055	0.077	2.21	0.446
	Initial Release (Proposed Max)	74 - 135	54.6 - 146[g]	min	1.12	4.96	0.86	1.18	1.14	0.055	0.015	0.039	0.36	0.28
				max	1.35	19.7	1.92	2.88	48.3	0.224	0.055	0.077	2.21	0.748
6A	Initial Release (Proposed Max)	28 - 135	31.6 - 146[h]	min	1.12	4.96	0.86	0.65	1.14	0.055	0.01	0.039	0.36	0.264
				max	1.35	19.7	1.92	2.88	48.3	0.224	0.055	0.077	2.21	0.748

a = considers average data from RMP 1997-1999 for Dumbarton Bridge Station as well as salt ponds at 31.6 and 42 ppt salinity
b = considers data from salt ponds with salinities of 31.6, & 42 ppt
c = considers data from salt ponds with salinities of 31.6, 42, 54.6, 89.4, & 89.8 ppt
d = considers average data from RMP 1997-1999 for Dumbarton Bridge Station as well as salt ponds at 31.6 and 42 ppt salinity
e = considers data from salt ponds with salinities of 31.6, 42, 54.6, 89.4, 89.8, 92.6, & 109 ppt
f = considers data from salt ponds with salinities of 42, 54.6, 89.4, 89.8, 92.6, & 109 ppt
g = considers data from salt ponds with salinities of 54.6, 89.4, 89.8, 92.6, 109, & 146 ppt
h = considers data from salt ponds with salinities of 31.6, 42, 54.6, 89.4, 89.8, 92.6, 109, & 146 ppt

Table 4 Cont'd. Estimated Range of Dissolved Metal Concentrations for Each Discharge Point during Initial Release and Continuous Circulation Periods

Discharge Point	Period of Interest	Predicted Salinity Range of Discharge (ppt)	Salinities of Surrogates Considered (ppt)		Estimated Dissolved Concentrations (ug/l) Cr	Ni	Cu	Zn	As	Se	Ag	Cd	Hg (ng/l)	Pb
West Bay Unit														
All Ponds	Continuous Circulation	15 - 44	15 - 42[e]	min	0.2	2.47	1.06	0.65	3.12	0.128	0.005	0.044	1.26	0.051
				max	1.22	8.05	2.55	1.21	10.7	0.298	0.012	0.065	1.3	0.307
SF-2	Initial Release (Proposed Max)	28 - 135	31.6 - 146[d]	min	1.12	4.96	0.86	0.65	1.14	0.055	0.01	0.039	0.36	0.264
				max	1.35	19.7	1.92	2.88	48.3	0.224	0.055	0.077	2.21	0.748
5S	Initial Release (Proposed Max)	28 - 135	31.6 - 146[d]	min	1.12	4.96	0.86	0.65	1.14	0.055	0.01	0.039	0.36	0.264
				max	1.35	19.7	1.92	2.88	48.3	0.224	0.055	0.077	2.21	0.748

d = considers data from salt ponds with salinities of 31.6, 42, 54.6, 89.4, 89.8, 92.6, 109, & 146 ppt

e = considers average data from RMP 1997-1999 for Dumbarton Bridge Station as well as data from salt ponds with salinity of 31.6 & 42 ppt

Table 5. Estimated Range of Total Metal Concentrations for Each Discharge Point during Initial Release and Continuous Circulation Periods

Discharge Point	Period of Interest	Predicted Salinity Range of Discharge (ppt)	Salinities of Surrogates Considered (ppt)		Estimated Total Concentrations (ug/l) Cr	Ni	Cu	Zn	As	Se	Ag	Cd	Hg (ng/l)	Pb
Alviso Ponds														
All Ponds	Continuous Circulation	12 - 44	13 - 42[a]	min	0.67	8.42	1.24	0.79	3.79	0.173	0.015	0.045	4.78	0.324
				max	6.94	11.8	5.92	10.45	11.9	0.42	0.0233	0.108	23.9	1.52
A2W	Initial Release (based on 2002)	27 - 31	19.6 - 31.6[b]	min	2.36	9.9	2.15	1.8	3.79	0.274	0.022	0.063	11.8	0.843
				max	6.94	11.8	5.9	10.5	6.36	0.42	0.023	0.11	23.9	1.52
	Initial Release (Proposed Max)	27 - 65	31.6 - 89.8[c]	min	0.67	7.09	1.24	0.79	1	0.092	0.013	0.05	3.37	0.324
				max	2.36	15.7	2.15	3.07	15.7	0.274	0.03	0.063	32	0.843
A3W	Initial Release (based on 2002)	28 - 31	19.6 - 31.6[b]	min	2.36	9.9	2.15	1.8	3.79	0.274	0.022	0.063	11.8	0.843
				max	6.94	11.8	5.9	10.5	6.36	0.42	0.023	0.11	23.9	1.52
	Initial Release (Proposed Max)	27 - 65	31.6 - 89.8[c]	min	0.67	7.09	1.24	0.79	1	0.092	0.013	0.05	3.37	0.324
				max	2.36	15.7	2.15	3.07	15.7	0.274	0.03	0.063	32	0.843
A7	Initial Release (based on 2002)	27 - 51	31.6 - 54.6[d]	min	0.67	7.09	1.24	0.79	1	0.092	0.013	0.045	3.37	0.324
				max	2.36	11.8	2.15	1.8	11.9	0.274	0.022	0.063	11.8	0.843
	Initial Release (Proposed Max)	26 - 110	31.6 - 109[e]	min	0.67	7.09	1.24	0.79	1	0.092	0.013	0.05	3.37	0.324
				max	2.36	18.1	2.15	3.38	20.1	0.274	0.15	0.063	44.5	0.843
A14	Initial Release (based on 2002)	36 - 75	31.6 - 89.8[c]	min	0.67	7.09	1.24	0.79	1	0.092	0.013	0.05	3.37	0.324
				max	2.36	15.7	2.15	3.07	15.7	0.274	0.03	0.063	32	0.843
	Initial Release (Proposed Max)	36 -100	31.6 - 109[e]	min	0.67	7.09	1.24	0.79	1	0.092	0.013	0.05	3.37	0.324
				max	2.36	18.1	2.15	3.38	20.1	0.274	0.15	0.063	44.5	0.843
A16	Initial Release (based on 2002)	44 - 83	42 - 89.8[f]	min	0.67	7.09	1.24	0.79	1	0.092	0.013	0.045	3.37	0.324
				max	1.07	15.7	1.59	3.07	15.7	0.173	0.03	0.054	32	0.392
	Initial Release (Proposed Max)	29 - 135	31.6 - 146[g]	min	0.67	7.09	1.24	0.79	1	0.092	0.013	0.05	3.37	0.324
				max	2.36	21.8	3.39	4.49	56.2	0.31	0.15	0.119	49.7	1.37
A19, A20, A21	Initial Release (Proposed Max)	29 - 135	31.6 - 146[g]	min	0.67	7.09	1.24	0.79	1	0.092	0.013	0.05	3.37	0.324
				max	2.36	21.8	3.39	4.49	56.2	0.31	0.15	0.119	49.7	1.37

a = considers average data from RMP 1997-1999 for South Bay Station as well as salt ponds at 31.6 and 42 ppt salinity
b = considers average data from RMP 1997-1999 for South Bay Station as well as salt pond at 31.6 ppt salinity
c = considers data from salt ponds with salinities of 31.6, 42, 54.6, 89.4, & 89.8 ppt
d = considers data from salt ponds with salinities of 31.6, 42, & 54.6 ppt
e = considers data from salt ponds with salinities of 31.6, 42, 54.6, 89.4, 89.8, 92.6, & 109 ppt
f = considers data from salt ponds with salinities of 42, 54.6, 89.4, & 89.8 ppt
g = considers data from salt ponds with salinities of 31.6, 42, 54.6, 89.4, 89.8, 92.6, 109, & 146 ppt

Table 5 Cont'd. Estimated Range of Total Metal Concentrations for Each Discharge Point during Initial Release and Continuous Circulation Periods

Discharge Point	Period of Interest	Predicted Salinity Range of Discharge (ppt)	Salinities of Surrogates Considered (ppt)		Estimated Total Concentrations (ug/l) Cr	Ni	Cu	Zn	As	Se	Ag	Cd	Hg (ng/l)	Pb
Baumberg Unit All Ponds	Continuous Circulation	15 - 44	15 - 42[a]	min	0.67	5.83	1.24	0.79	3.18	0.173	0.016	0.045	4.78	0.324
				max	3.67	11.8[i]	4.27	5.48	11.9	0.363	0.022	0.098	16	0.843
2	Initial Release (based on 2002)	30 - 37	31.6 - 42[b]	min	0.67	8.42[i]	1.24	0.79	6.36	0.173	0.015	0.045	4.78	0.324
				max	2.36	11.8[i]	2.15	1.8	11.9	0.274	0.022	0.063	11.8	0.843
	Initial Release (Proposed Max)	30 - 65	31.6 - 89.8[c]	min	0.67	7.09	1.24	0.79	1	0.092	0.013	0.045	3.37	0.324
				max	2.36	15.7[i]	2.15	3.07	15.7	0.274	0.03	0.063	32[j]	0.843
11	Initial Release (based on 2002)	25 - 35	20.9 - 42[d]	min	0.67	5.83	1.24	0.79	3.18	0.173	0.016	0.045	4.78	0.324
				max	3.67	11.8[i]	4.27	5.48	11.9	0.363	0.022	0.098	16	0.843
	Initial Release (Proposed Max)	28 - 65	31.6 - 89.8[c]	min	0.67	7.09	1.24	0.79	1	0.092	0.013	0.045	3.37	0.324
				max	2.36	15.7[i]	2.15	3.07	15.7	0.274	0.03	0.063	32[j]	0.843
2C	Initial Release (based on 2002)	30 - 37	31.6 - 42[b]	min	0.67	8.42[i]	1.24	0.79	6.36	0.173	0.015	0.045	4.78	0.324
				max	2.36	11.8[i]	2.15	1.8	11.9	0.274	0.022	0.063	11.8	0.843
	Initial Release (Proposed Max)	32 - 100	31.6 - 109[e]	min	0.67	7.09	1.24	0.79	1	0.092	0.013	0.05	3.37	0.324
				max	2.36	18.1[g]	2.15	3.38	20.1	0.274	0.15	0.063	44.5[j]	0.843
8A	Initial Release (based on 2002)	48 - 98	42 - 109[f]	min	0.67	7.09	1.24	0.79	1	0.092	0.013	0.045	3.37	0.324
				max	1.23	11.8[i]	2.04	3.38	20.1	0.22	0.15	0.062	44.5[j]	0.619
	Initial Release (Proposed Max)	74 - 135	54.6 - 146[g]	min	0.67	7.09	1.37	1.28	1	0.092	0.013	0.05	3.37	0.351
				max	1.23	21.8[i]	3.39	4.49	56.2	0.31	0.15	0.119	49.7[j]	1.37
6A	Initial Release (Proposed Max)	28 - 135	31.6 - 146[h]	min	0.67	7.09	1.24	0.79	1	0.092	0.013	0.05	3.37	0.324
				max	2.36	21.8[i]	3.39	4.49	56.2	0.31	0.15	0.119	49.7[j]	1.37

a = considers average data from RMP 1997-1999 for Dumbarton Bridge Station as well as salt ponds at 31.6 and 42 ppt salinity
b = considers data from salt ponds with salinities of 31.6, & 42 ppt
c = considers data from salt ponds with salinities of 31.6, 42, 54.6, 89.4, & 89.8 ppt
d = considers average data from RMP 1997-1999 for Dumbarton Bridge Station as well as salt ponds at 31.6 and 42 ppt salinity
e = considers data from salt ponds with salinities of 31.6, 42, 54.6, 89.4, 89.8, 92.6, & 109 ppt
f = considers data from salt ponds with salinities of 42, 54.6, 89.4, 89.8, 92.6, & 109 ppt
g = considers data from salt ponds with salinities of 54.6, 89.4, 89.8, 92.6, 109, & 146 ppt
h = considers data from salt ponds with salinities of 31.6, 42, 54.6, 89.4, 89.8, 92.6, 109, & 146 ppt
i - Estimated maximum values exceed Basin Plan WQO of 7.1 ug/l (total Ni); applicable to Baumberg and West Bay Ponds discharge
j - Estimated maximum values exceed Basin Plan WQO of 25 ng/l (total Hg); applicable to Baumberg and West Bay Ponds discharge

Table 5 Cont'd. Estimated Range of Total Metal Concentrations for Each Discharge Point during Initial Release and Continuous Circulation Periods

Discharge Point	Period of Interest	Predicted Salinity Range of Discharge (ppt)	Salinities of Surrogates Considered (ppt)		Estimated Total Concentrations (ug/l) Cr	Ni	Cu	Zn	As	Se	Ag	Cd	Hg (ng/l)	Pb
West Bay Unit														
All Ponds	Continuous Circulation	15 - 44	15 - 42[e]	min	0.67	5.83	1.24	0.79	3.18	0.173	0.016	0.045	4.78	0.324
				max	3.67	11.8[g]	4.27	5.48	11.9	0.363	0.022	0.098	16	0.843
SF-2	Initial Release (Proposed Max)	28 - 135	31.6 - 146[d]	min	0.67	7.09	1.24	0.79	1	0.092	0.013	0.05	3.37	0.324
				max	2.36	21.8[g]	3.39	4.49	56.2	0.31	0.15	0.119	49.7[h]	1.37
5S	Initial Release (Proposed Max)	28 - 135	31.6 - 146[d]	min	0.67	7.09	1.24	0.79	1	0.092	0.013	0.05	3.37	0.324
				max	2.36	21.8[g]	3.39	4.49	56.2	0.31	0.15	0.119	49.7[h]	1.37

d = considers data from salt ponds with salinities of 31.6, 42, 54.6, 89.4, 89.8, 92.6, 109, & 146 ppt
e = considers average data from RMP 1997-1999 for Dumbarton Bridge Station as well as data from salt ponds with salinity of 31.6 & 42 ppt
g - Estimated maximum values exceed Basin Plan WQO of 7.1 ug/l (total Ni); applicable to Baumberg and West Bay Ponds discharge
h - Estimated maximum values exceed Basin Plan WQO of 25 ng/l (total Hg); applicable to Baumberg and West Bay Ponds discharge

Table 6. Comparison of Estimated Nickel Concentrations in Discharges vs WQOs

Discharge Point	Period of Interest	Predicted Salinity of Discharge (ppt)	Estimated Range of Discharge Concentrations: Dissolved Ni (ug/l)	Estimated Range of Discharge Concentrations: Total Ni (ug/l)
Applicable Limits			**11.9**	**7.1**
Alviso Ponds				
All Ponds	Continuous Circulation	12 - 44	3.1 - 8.05	
A2W	Initial Release (2002 Salinity)	27 - 31	3.1 - 8.05	
	Initial Release (Max Salinity)	27 - 65	4.96 - 10.8	
A3W	Initial Release (2002 Salinity)	28 - 31	3.1 - 8.05	
	Initial Release (Max Salinity)	27 - 65	4.96 - 10.8	
A7	Initial Release (2002 Salinity)	27 - 51	4.96 - 7.45	
	Initial Release (Max Salinity)	26 - 110	4.96 - **12.8**	
A14	Initial Release (2002 Salinity)	36 - 75	4.96 - 10.8	
		36 -100	4.96 - **12.8**	
A16	Initial Release (2002 Salinity)	44 - 83	4.96 - 10.8	
	Initial Release (Max Salinity)	29 - 135	4.96 - **19.7**	
A19, A20, A21	Initial Release (Max Salinity)	29 - 135	4.96 - **19.7**	
Baumberg Unit				
All Ponds	Continuous Circulation	15 - 44		5.83 - **11.8**
2	Initial Release (2002 Salinity)	30 - 37		**8.42 - 11.8**
	Initial Release (Max Salinity)	30 - 65		7.09 - **15.7**
10	Initial Release (2002 Salinity)	25 - 35		5.83 - **11.8**
	Initial Release (Max Salinity)	28 - 65		7.09 - **15.7**
2C	Initial Release (2002 Salinity)	30 - 37		**8.42 - 11.8**
	Initial Release (Max Salinity)	32 - 100		7.09 - **18.1**
8A	Initial Release (2002 Salinity)	48 - 98		7.09 - **11.8**
	Initial Release (Max Salinity)	74 - 135		7.09 - **21.8**
6A	Initial Release (Max Salinity)	28 - 135		7.09 -**21.8**
West Bay Unit				
All Ponds	Continuous Circulation	15 - 44		5.83 - **11.8**
SF-2	Initial Release (Max Salinity)	28 - 135		7.09 - **21.8**
5S	Initial Release (Max Salinity)	28 - 135		7.09 - **21.8**

Table 7. Comparison of Estimated Mercury Concentrations in Discharges vs WQOs

Discharge Point	Period of Interest	Predicted Salinity of Discharge (ppt)	Estimated Range of Discharge Concentrations Total Hg (ng/l)	Total Hg (ng/l)
Applicable Limits			**51**	**25**
Alviso Ponds				
All Ponds	Continuous Circulation	12 - 44	4.78 - 23.9	
A2W	Initial Release (2002 Salinity)	27 - 31	11.8 - 23.9	
	Initial Release (Max Salinity)	27 - 65	3.37 - 32	
A3W	Initial Release (2002 Salinity)	28 - 31	11.8 - 23.9	
	Initial Release (Max Salinity)	27 - 65	3.37 - 32	
A7	Initial Release (2002 Salinity)	27 - 51	3.37 - 11.8	
	Initial Release (Max Salinity)	26 - 110	3.37 - 44.5	
A14	Initial Release (2002 Salinity)	36 - 75	3.37 - 32	
		36 -100	3.37 - 44.5	
A16	Initial Release (2002 Salinity)	44 - 83	3.37 - 32	
	Initial Release (Max Salinity)	29 - 135	3.37 - 49.7	
A19, A20, A21	Initial Release (Max Salinity)	29 - 135	3.37 - 49.7	
Baumberg Unit				
All Ponds	Continuous Circulation	15 - 44		4.78 - 16
2	Initial Release (2002 Salinity)	30 - 37		4.78 - 11.8
	Initial Release (Max Salinity)	30 - 65		3.37 - **32**
10	Initial Release (2002 Salinity)	25 - 35		4.78 - 16
	Initial Release (Max Salinity)	28 - 65		3.37 - **32**
2C	Initial Release (2002 Salinity)	30 - 37		4.78 - 11.8
	Initial Release (Max Salinity)	32 - 100		3.37 - **44.5**
8A	Initial Release (2002 Salinity)	48 - 98		3.37 - **44.5**
	Initial Release (Max Salinity)	74 - 135		3.37 - **49.7**
6A	Initial Release (Max Salinity)	28 - 135		3.37 - **49.7**
West Bay Unit				
All Ponds	Continuous Circulation	15 - 44		4.78 - 16
SF-2	Initial Release (Max Salinity)	28 - 135		3.37 - **49.7**
5S	Initial Release (Max Salinity)	28 - 135		3.37 - **49.7**

Table 8. Data Used in Estimation of Nickel Concentrations in Waterbodies Assoicated with the Alviso Unit

Receiving Waterbody	Period of Interest	Estimated Maximum Pond Discharge Concentrations: Discharge Pond	Applicable Period	Dissolved Ni (ug/l)	Receiving Water Concentrations from 1997-99 RMP Dissolved Ni (ug/l)	South Bay	Coyote Creek mouth	Coyote Creek SJSC	Coyote Creek Standish	Guadalupe River
					Data from April only - for Initial Release Period					
					min	1.8	2.0	3.0	1.7	2.1
					max	2.9	4.9	5.6	6.1	4.3
					mean	2.4	3.1	4.1	3.3	3.5
Alviso Slough										
	Initial Release	A7	wks 1-7	12.8	max	2.9				4.3
	(Proposed Max)		wk 8	8.05	mean	2.4				3.5
Coyote Creek										
	Initial Release	A14	wks 1-7	12.8	max	2.9		5.6		
	(Proposed Max)		wk 8	8.05	mean	2.4		4.1		
		A16	wks 1-7	19.7						
			wk 8	8.05						
Souath Bay Proper										
	Initial Release	A2W & A3W	wks 1-7	10.8	max	2.9		5.6		
	(Proposed Max)		wk 8	8.05	mean	2.4		4.1		
		A7	wks 1-7	12.8						
			wk 8	8.05						
		A14	wks 1-7	12.8						
			wk 8	8.05						
		A16	wks 1-7	19.7						
			wk 8	8.05						

Table 9. Predicted Effect of Iniital Release on Dissolved Nickel in Alviso Slough

(Conditions: Initial Release initiated April 1, salinity of discharge from Pond A7at "proposed maximum")

A. Based on Avg Bay Ni & Avg Alviso Slough Ni

Alviso Sl Reach[1]	Week #3 of Initial Release[2]			End of Initial Release[3]		
	Est. Dissolved Ni (ug/l)		Est. ? Ni (ug/l)	Est. Dissolved Ni (ug/l)		Est. ? Ni (ug/l)
	Existing Cond.	Initial Relase Cond.		Existing Cond.	Initial Relase Cond.	
1	2.42	3.57	**1.15**	2.42	3.18	**0.76**
2	2.67	4.61	**1.94**	2.67	3.77	**1.10**
3	2.88	5.44	**2.56**	2.90	4.21	**1.31**
4	3.00	5.83	**2.83**	3.06	4.41	**1.35**
5	3.12	5.76	**2.64**	3.19	4.41	**1.22**
6	3.25	5.08	**1.83**	3.31	4.19	**0.88**
7	3.38	4.26	**0.88**	3.41	3.88	**0.47**
8	3.47	3.79	**0.32**	3.48	3.65	**0.17**

B. Based on Max Bay Ni & Max Alviso Slough Ni

Alviso Sl Reach[1]	Week #3 of Initial Release[2]			End of Initial Release[3]		
	Est. Dissolved Ni (ug/l)		Est. ? Ni (ug/l)	Est. Dissolved Ni (ug/l)		Est. ? Ni (ug/l)
	Existing Cond.	Initial Relase Cond.		Existing Cond.	Initial Relase Cond.	
1	2.92	4.02	**1.10**	2.93	3.62	**0.69**
2		5.09	**#VALUE!**	3.24	4.23	**0.99**
3	3.51	5.93	**2.42**	3.53	4.70	**1.17**
4	3.67	6.33	**2.66**	3.74	4.93	**1.19**
5	3.82	6.30	**2.48**	3.90	4.98	**1.08**
6	3.98	5.70	**1.72**	4.06	4.83	**0.77**
7	4.16	4.97	**0.81**	4.19	4.60	**0.41**
8	4.26	4.56	**0.30**	4.27	4.42	**0.15**

1 - see Figure 1 for location of Alviso Slough reaches
2 - highest Ni concentrations occur in week #3
3 - assume max Ni concentrations predicted for continuous circulation period

Table 10A. Predicted Effect of Iniital Release on Dissolved Nickel in Coyote Creek & Artesian Slough

(Conditions: Initial Release initiated April 1, salinity of discharge from Ponds A14 and A16 at "proposed maximum")

A. Based on Avg Bay Ni & Avg Coyote Creek Ni

Coyote Cr Reach[1]	Week #2 of Initial Release[4]			End of Initial Release[3]		
	Est. Dissolved Ni (ug/l)		Est. ? Ni	Est. Dissolved Ni (ug/l)		Est. ? Ni
	Existing Cond.	Initial Relase Cond.	(ug/l)	Existing Cond.	Initial Relase Cond.	(ug/l)
1	2.40	2.80	**0.40**	2.40	2.76	**0.36**
2	2.40	2.90	**0.50**	2.40	2.80	**0.40**
3	2.40	3.06	**0.66**	2.40	2.85	**0.45**
4	2.43	3.25	**0.82**	2.47	2.99	**0.52**
5	2.73	3.74	**1.01**	2.73	3.33	**0.60**
6	3.04	4.15	**1.11**	3.04	3.63	**0.59**
7	3.39	4.36	**0.97**	3.37	3.86	**0.49**
8	3.57	4.42	**0.85**	3.57	4.00	**0.43**
9	3.90	4.41	**0.51**	3.91	4.19	**0.28**
10	4.05	4.36	**0.31**	4.05	4.25	**0.20**
11	4.10	4.23	**0.13**	4.10	4.18	**0.08**

B. Based on Max Bay Ni & Max Coyote Creek Ni

Coyote Cr Reach[1]	Week #2 of Initial Release[4]			End of Initial Release[3]		
			Est. ? Ni	Est. Dissolved Ni (ug/l)		Est. ? Ni
	Existing Cond.	Initial Relase Cond.	(ug/l)	Existing Cond.	Initial Relase Cond.	(ug/l)
1	2.90	3.28	**0.38**	2.90	3.23	**0.33**
2	2.90	3.38	**0.48**	2.90	3.26	**0.36**
3	2.90	3.53	**0.63**	2.90	3.31	**0.41**
4	2.95	3.76	**0.81**	3.00	3.51	**0.51**
5	3.42	4.40	**0.98**	3.43	3.99	**0.56**
6	3.91	4.99	**1.08**	3.91	4.46	**0.55**
7	4.47	5.41	**0.94**	4.45	4.89	**0.44**
8	4.76	5.57	**0.81**	4.76	5.14	**0.38**
9	5.28	5.76	**0.48**	5.29	5.52	**0.23**
10	5.53	5.81	**0.28**	5.52	5.66	**0.14**
11	5.60	5.72	**0.12**	5.60	5.65	**0.05**

1 - see Figure 2 for location of Coyote Creek/Artesian Slough reaches
2 - highest Ni concentrations occur in Artesian Slough in week #1
3 - assume max Ni concentrations predicted for continuous circulation period
4 - highest Ni concentrations occur in Coyote Creek in week #2

Table 10B. Predicted Effect of Iniital Release on Dissolved Nickel in Coyote Creek & Artesian Slough

(Conditions: Initial Release initiated April 1, salinity of discharge from Ponds A14 and A16 at "proposed maximum")

A. Based on Avg Bay Ni & Avg Coyote Creek Ni

Coyote Cr Reach[1]	Week #1 of Initial Release[2]			End of Initial Release[3]		
	Est. Dissolved Ni (ug/l)		Est. ? Ni	Est. Dissolved Ni (ug/l)		Est. ? Ni
	Existing Cond.	Initial Relase Cond.	(ug/l)	Existing Cond.	Initial Relase Cond.	(ug/l)
1	2.40	2.54	**0.14**	2.40	2.76	**0.36**
2	2.40	2.65	**0.25**	2.40	2.80	**0.40**
3	2.40	2.80	**0.40**	2.40	2.85	**0.45**
4	2.40	3.01	**0.61**	2.47	2.99	**0.52**
5	2.59	3.50	**0.91**	2.73	3.33	**0.60**
6	2.88	3.98	**1.10**	3.04	3.63	**0.59**
7	3.24	4.45	**1.21**	3.37	3.86	**0.49**
8	3.43	4.72	**1.29**	3.57	4.00	**0.43**
9	3.84	5.32	**1.48**	3.91	4.19	**0.28**
10	4.04	5.62	**1.58**	4.05	4.25	**0.20**
11	4.10	5.10	**1.00**	4.10	4.18	**0.08**

B. Based on Max Bay Ni & Max Coyote Creek Ni

Coyote Cr Reach[1]	Week #1 of Initial Release[2]			End of Initial Release[3]		
			Est. ? Ni	Est. Dissolved Ni (ug/l)		Est. ? Ni
	Existing Cond.	Initial Relase Cond.	(ug/l)	Existing Cond.	Initial Relase Cond.	(ug/l)
1	2.90	3.03	**0.13**	2.90	3.23	**0.33**
2	2.90	3.14	**0.24**	2.90	3.26	**0.36**
3	2.90	3.28	**0.38**	2.90	3.31	**0.41**
4	2.90	3.49	**0.59**	3.00	3.51	**0.51**
5	3.21	4.10	**0.89**	3.43	3.99	**0.56**
6	3.67	4.73	**1.06**	3.91	4.46	**0.55**
7	4.23	5.39	**1.16**	4.45	4.89	**0.44**
8	4.54	5.74	**1.20**	4.76	5.14	**0.38**
9	5.18	6.55	**1.37**	5.29	5.52	**0.23**
10	5.50	6.94	**1.44**	5.52	5.66	**0.14**
11	5.60	6.50	**0.90**	5.60	5.65	**0.05**

1 - see Figure 2 for location of Coyote Creek/Artesian Slough reaches
2 - highest Ni concentrations occur in Artesian Slough in week #1
3 - assume max Ni concentrations predicted for continuous circulation period
4 - highest Ni concentrations occur in Coyote Creek in week #2

Table 11. Predicted Effect of Iniital Release on Dissolved Nickel in South Bay near Alviso Unit

(Conditions: Initial Release initiated April 1, salinity of discharge from Ponds A2w, A3w, A7, A14, & A16 at "proposed maximum"

A. Based on Avg Bay Ni & Avg Slough Ni

So. Bay Reach[1]	Week #3 of Initial Release[2]			End of Initial Release[3]		
	Est. Dissolved Ni (ug/l)		Est. ? Ni (ug/l)	Est. Dissolved Ni (ug/l)		Est. ? Ni (ug/l)
	Existing Cond.	Initial Relase Cond.		Existing Cond.	Initial Relase Cond.	
1	2.40	2.77	**0.37**	2.40	2.71	**0.31**
2	2.40	2.68	**0.28**	2.40	2.66	**0.26**

A. Based on Max Bay Ni & Max Slough Ni

So. Bay Reach[1]	Week #3 of Initial Release[2]			End of Initial Release[3]		
	Est. Dissolved Ni (ug/l)		Est. ? Ni (ug/l)	Est. Dissolved Ni (ug/l)		Est. ? Ni (ug/l)
	Existing Cond.	Initial Relase Cond.		Existing Cond.	Initial Relase Cond.	
1	2.90	3.25	**0.35**	2.90	3.18	**0.28**
2	2.90	3.17	**0.27**	2.90	3.13	**0.23**

1 - see Figure 3 for location of South Bay reaches
2 - highest Ni concentrations occur in week #3
3 - assume max Ni concentrations predicted for continuous circulation period

Table 12. Data Used in Estimation of Nickel Concentrations in Waterbodies Associated with the Baumberg Unit

Receiving Waterbody	Period of Interest	Estimated Maximum Pond Discharge Concentrations: Discharge Pond	Applicable Period	Total Ni (ug/l)	Receiving Water Concentrations (Bay = 1997-99 RMP; AFCC = 1990 ACURCWP)* Total Ni (ug/l)	Bay @ Dumbarton	Alameda FCC
						Data from April only	
					min	4.5	
					max	8.4	2.0
					mean	5.9	2.0
						Data from entire year	
					min	4.3	1.0
					max	9.7	3.0
					mean	6.5	2.0
AFCC	Initial Release (based on 2002)	2C	wks 1-7	11.8	max	8.4	2
			wk 8	11.8	mean	5.9	2
		2	wks 1-7	11.8			
			wk 8	11.8			
	Initial Release	2C	wks 1-7	18.1	max	8.4	2
			wk 8	11.8	mean	5.9	2
		2	wks 1-7	15.7			
			wk 8	11.8			
	Continuous Circulation	2C	all	11.8	max	9.7	3
					mean	6.5	2
		2	all	11.8			
South Bay Proper	Initial Release (based on 2002)	2C	wks 1-7	11.8	max	8.4	2
			wk 8	11.8	mean	5.9	2
		2 & 10	wks 1-7	11.8			
			wk 8	11.8			
	Initial Release (Proposed Max)	2C	wks 1-7	18.1	max	8.4	2
			wk 8	11.8	mean	5.9	2
		2 & 10	wks 1-7	15.7			
			wk 8	11.8			
	Continuous Circulation	2C	all	11.8	max	9.7	2
					mean	6.5	2
		2 & 10	all	11.8			

* RMP = San Francisco Estuary Regional Monitoring Program for Toxic Substance
ACURCWP = Alameda County Urban Runoff Clean Water Program

Table 13. Predicted Effect of Iniital Release on Total Nickel in Alameda Flood Control Channel

(Conditions: Initial Release initiated April 1, salinity of discharge from Ponds 2, 10, 2C at "proposed maximum")

A. Based on Avg Bay Ni & Avg AFCC Ni

Alameda FCC Reach[1]	Week #5 of Initial Release[2] Est. Total Ni (ug/l) Existing Cond.	Initial Relase Cond.	Est. ? Ni (ug/l)	End of Initial Release[3] Est. Total Ni (ug/l) Existing Cond.	Initial Relase Cond.	Est. ? Ni (ug/l)
1	5.90	7.52	**1.62**	5.90	6.70	**0.80**
2	5.90	7.95	**2.05**	5.90	6.85	**0.95**
3	5.62	8.19	**2.57**	5.55	6.67	**1.12**
4	4.61	7.07	**2.46**	4.62	5.66	**1.04**
5	3.40	5.57	**2.17**	3.55	4.52	**0.97**
6	2.36	3.68	**1.32**	2.58	3.32	**0.74**
7	2.02	2.17	**0.15**	2.07	2.28	**0.21**
8	2.00	2.00	**0.00**	2.00	2.01	**0.01**

B. Based on Max Bay Ni & Avg AFCC Ni

Alameda FCC Reach[1]	Week #5 of Initial Release[2] Est. Total Ni (ug/l) Existing Cond.	Initial Relase Cond.	Est. ? Ni (ug/l)	End of Initial Release[3] Est. Total Ni (ug/l) Existing Cond.	Initial Relase Cond.	Est. ? Ni (ug/l)
1	8.40	9.67	**1.27**	8.40	8.81	**0.41**
2		10.01	**#VALUE!**	8.40	8.91	**0.51**
3	7.94	9.98	**2.04**	7.83	8.44	**0.61**
4	6.28	8.27	**1.99**	6.30	6.91	**0.61**
5	4.30	6.15	**1.85**	4.55	5.20	**0.65**
6	2.58	3.81	**1.23**	2.95	3.54	**0.59**
7	2.03	2.19	**0.16**	2.12	2.32	**0.20**
8	2.01	2.01	**0.00**	2.01	2.01	**0.00**

1 - see Figure 4 for location of Alameda Flood Control Channel reaches
2 - highest Ni concentrations occur in week #5
3 - assume max Ni concentrations predicted for continuous circulation period

Table 14. Predicted Effect of Iniital Release on Total Nickel in Alameda Flood Control Channel

(Conditions: Initial Release initiated April 1, salinity of discharge from Ponds 2, 10, 2C at "2002 values")

A. Based on Avg Bay Ni & Avg AFCC Ni

Alviso Sl Reach[1]	Week #5 of Initial Release[2]			End of Initial Release[3]		
	Est. Total Ni (ug/l)		Est. ? Ni (ug/l)	Est. Total Ni (ug/l)		Est. ? Ni (ug/l)
	Existing Cond.	Initial Relase Cond.		Existing Cond.	Initial Relase Cond.	
1	5.90	6.71	**0.81**	5.90	6.70	**0.80**
2	5.90	6.91	**1.01**	5.90	6.85	**0.95**
3	5.62	6.88	**1.26**	5.55	6.67	**1.12**
4	4.61	5.84	**1.23**	4.62	5.66	**1.04**
5	3.40	4.54	**1.14**	3.55	4.52	**0.97**
6	2.36	3.10	**0.74**	2.58	3.32	**0.74**
7	2.02	2.11	**0.09**	2.07	2.28	**0.21**
8	2.00	2.00	**0.00**	2.00	2.01	**0.01**

B. Based on Max Bay Ni & Avg AFCC Ni

Alviso Sl Reach[1]	Week #5 of Initial Release[2]			End of Initial Release[3]		
	Est. Total Ni (ug/l)		Est. ? Ni (ug/l)	Est. Total Ni (ug/l)		Est. ? Ni (ug/l)
	Existing Cond.	Initial Relase Cond.		Existing Cond.	Initial Relase Cond.	
1	8.40	8.86	**0.46**	8.40	8.81	**0.41**
2		8.98	**#VALUE!**	8.40	8.91	**0.51**
3	7.94	8.67	**0.73**	7.83	8.44	**0.61**
4	6.28	7.04	**0.76**	6.30	6.91	**0.61**
5	4.30	5.12	**0.82**	4.55	5.20	**0.65**
6	2.58	3.23	**0.65**	2.95	3.54	**0.59**
7	2.03	2.13	**0.10**	2.12	2.32	**0.20**
8	2.01	2.01	**0.00**	2.01	2.01	**0.00**

1 - see Figure 4 for location of Alameda Flood Control Channel reaches
2 - highest Ni concentrations occur in week #5
3 - assume max Ni concentrations predicted for continuous circulation period

Table 15. Predicted Effect of Continuous Circulation on Total Nickel in Alameda Flood Control Channel

(Conditions: Continuous Circulation starting June 1, salinity of discharge from Ponds 2, 10, 2C at "2002 values")

A. Based on Avg Bay Ni & Avg AFCC Ni

Alviso Sl Reach[1]	First Week in May of Continuous Circulation[2]			Second Week in Sept of Continuous Circulation[3]		
	Est. Total Ni (ug/l)		Est. ? Ni (ug/l)	Est. Total Ni (ug/l)		Est. ? Ni (ug/l)
	Existing Cond.	Initial Relase Cond.		Existing Cond.	Initial Relase Cond.	
1	6.50	7.22	**0.72**	6.50	7.44	**0.94**
2	6.50	7.41	**0.91**	6.50	7.60	**1.10**
3	6.18	7.31	**1.13**	6.50	7.80	**1.30**
4	5.01	6.13	**1.12**	6.50	7.86	**1.36**
5	3.62	4.68	**1.06**	5.90	7.11	**1.21**
6	2.41	3.13	**0.72**	4.60	5.85	**1.25**
7	2.02	2.12	**0.10**	3.36	4.32	**0.96**
8	2.00	2.00	**0.00**	2.47	3.01	**0.54**

B. Based on Max Bay Ni & Avg AFCC Ni

Alviso Sl Reach[1]	First Week in May of Continuous Circulation[2]			Second Week in Sept of Continuous Circulation[3]		
	Est. Total Ni (ug/l)		Est. ? Ni (ug/l)	Est. Total Ni (ug/l)		Est. ? Ni (ug/l)
	Existing Cond.	Initial Relase Cond.		Existing Cond.	Initial Relase Cond.	
1	9.70	9.97	**0.27**	9.70	10.04	**0.34**
2		10.05	**#VALUE!**	9.70	10.11	**0.41**
3	9.15	9.60	**0.45**	9.70	10.19	**0.49**
4	7.15	7.67	**0.52**	9.70	10.22	**0.52**
5	4.76	5.43	**0.67**	8.67	8.89	**0.22**
6	2.70	3.30	**0.60**	6.44	6.91	**0.47**
7	2.04	2.13	**0.09**	4.33	4.91	**0.58**
8	2.01	2.01	**0.00**	2.81	3.27	**0.46**

1 - see Figure 4 for location of Alameda Flood Control Channel reaches
2 - representative early spring conditions
3 - representative late summer conditions

Table 16. Predicted Effect of Iniital Release on Total Nickel in South Bay near Baumberg Unit

(Conditions: Initial Release initiated April 1, salinity of discharge from Ponds 2, 10, 2C at "proposed maximum")

A. Based on Avg Bay Ni & Avg AFCC Ni

So. Bay Reach[1]	Week #6 of Initial Release[2]			End of Initial Release[3]		
	Est. Total Ni (ug/l)		Est. ? Ni	Est. Total Ni (ug/l)		Est. ? Ni
	Existing Cond.	Initial Relase Cond.	(ug/l)	Existing Cond.	Initial Relase Cond.	(ug/l)
1	6.50	7.04	**0.54**	6.50	6.69	**0.19**
2	6.50	6.73	**0.23**	6.50	6.58	**0.08**

B. Based on Max Bay Ni & Avg AFCC Ni

So. Bay Reach[1]	Week #6 of Initial Release[2]			End of Initial Release[3]		
	Est. Total Ni (ug/l)		Est. ? Ni	Est. Total Ni (ug/l)		Est. ? Ni
	Existing Cond.	Initial Relase Cond.	(ug/l)	Existing Cond.	Initial Relase Cond.	(ug/l)
1	8.40	8.78	**0.38**	8.40	8.47	**0.07**
2	8.40	8.56	**0.16**	8.40	8.43	**0.03**

1 - see Figure 3 for location of South Bay reaches
2 - highest Ni concentrations occur in week #6
3 - assume max Ni concentrations predicted for continuous circulation period

Table 17. Predicted Effect of Iniital Release on Total Nickel in South Bay near Baumberg Unit

(Conditions: Initial Release initiated April 1, salinity of discharge from Ponds 2, 10, 2C at "2002 Values")

A. Based on Avg Bay Ni & Avg AFCC Ni

So. Bay Reach[1]	Week #6 of Initial Release[2]			End of Initial Release[3]		
	Est. Total Ni (ug/l)		Est. ? Ni (ug/l)	Est. Total Ni (ug/l)		Est. ? Ni (ug/l)
	Existing Cond.	Initial Relase Cond.		Existing Cond.	Initial Relase Cond.	
1	6.50	6.74	**0.24**	6.50	6.69	**0.19**
2	6.50	6.60	**0.10**	6.50	6.58	**0.08**

B. Based on Max Bay Ni & Avg AFCC Ni

So. Bay Reach[1]	Week #6 of Initial Release[2]			End of Initial Release[3]		
	Est. Total Ni (ug/l)		Est. ? Ni (ug/l)	Est. Total Ni (ug/l)		Est. ? Ni (ug/l)
	Existing Cond.	Initial Relase Cond.		Existing Cond.	Initial Relase Cond.	
1	8.40	8.48	**0.08**	8.40	8.47	**0.07**
2	8.40	8.43	**0.03**	8.40	8.43	**0.03**

1 - see Figure 3 for location of South Bay reaches
2 - highest Ni concentrations occur in week #6
3 - assume max Ni concentrations predicted for continuous circulation period

Table 18. Predicted Effect of Continuous Circulation on Total Nickel in South Bay near Baumberg Unit

(Conditions: Continuous Circulation starts June 1, salinity of discharge from Ponds 2, 10, 2C at "2002 Values")

A. Based on Avg Bay Ni & Avg AFCC Ni

So. Bay Reach[1]	First Week in May of Continuous Circulation[2]			Second Week in Sept of Continuous Circulation[3]		
	Est. Total Ni (ug/l)		Est. ? Ni (ug/l)	Est. Total Ni (ug/l)		Est. ? Ni (ug/l)
	Existing Cond.	Cont. Circulation		Existing Cond.	Cont. Circulation	
1	6.50	6.71	**0.21**	6.50	6.96	**0.46**
2	6.50	6.58	**0.08**	6.50	6.75	**0.25**

B. Based on Max Bay Ni & Avg AFCC Ni

So. Bay Reach[1]	First Week in May of Continuous Circulation[2]			Second Week in Sept of Continuous Circulation[3]		
	Est. Total Ni (ug/l)		Est. ? Ni (ug/l)	Est. Total Ni (ug/l)		Est. ? Ni (ug/l)
	Existing Cond.	Cont. Circulation		Existing Cond.	Cont. Circulation	
1	9.70	9.70	**0.00**	9.70	9.88	**0.18**
2	9.70	9.70	**0.00**	9.70	9.81	**0.11**

1 - see Figure 3 for location of South Bay reaches
2 - representative of early spring conditions
3 - representative of late summer conditions

Table 19. Data Used in Estimation of Mercury Concentrations in Waterbodies Associated with the Baumberg Unit

Receiving Waterbody	Period of Interest	Estimated Maximum Pond Discharge Concentrations			Receiving Water Concentrations (Bay = 1997-99 RMP; AFCC = 1990 ACURCWP)* Total Hg (ng/l)		
		Discharge Pond	Applicable Period	Total Hg (ng/l)		Bay @ Dumbarton	Alameda FCC
						Data from April only	
					min	5.4	
					max	35.9	
					mean	20.7	
						Data from entire year	
					min	5.4	16.3
					max	35.9	31.4
					mean	18.6	23.9
AFCC							
	Initial Release (Proposed Max)	2C	wks 1-7	44.5	max	35.9	31.4
			wk 8	16	mean	20.7	23.9
		2 & 10	wks 1-7	32			
			wk 8	16			
		8A	wks 1-7	49.7			
			wk 8	16			
South Bay Proper							
	Initial Release (Proposed Max)	2C	wks 1-7	44.5	max	35.9	31.4
			wk 8	16	mean	20.7	23.9
		2 & 10	wks 1-7	32			
			wk 8	16			
		8A	wks 1-7	49.7			
			wk 8	16			

* RMP = San Francisco Estuary Regional Monitoring Program for Toxic Substance
ACURCWP = Alameda County Urban Runoff Clean Water Program

Table 20. Predicted Effect of Iniital Release on Total Mercury in Alameda Flood Control Channel

(Conditions: Initial Release initiated April 1, salinity of discharge from Ponds 2, 2C, 10, and 8A at "proposed maximum")

A. Based on Avg Bay Hg & Avg AFCC Hg

AFCC Reach[1]	Week #2 of Initial Release[2]			End of Initial Release[3]		
	Est. Total Hg (ng/l)		Est. ? Hg (ng/l)	Est. Total Hg (ng/l)		Est. ? Hg (ng/l)
	Existing Cond.	Initial Relase Cond.		Existing Cond.	Initial Relase Cond.	
1	20.70	23.14	**2.44**	20.70	19.96	**-0.74**
2	20.70	23.46	**2.76**	20.70	19.86	**-0.84**
3	21.19	24.31	**3.12**	20.70	20.03	**-0.67**
4	22.10	24.71	**2.61**	20.70	20.87	**0.17**
5	23.17	25.03	**1.86**	20.99	21.82	**0.83**
6	23.77	24.51	**0.74**	21.75	22.82	**1.07**
7	23.89	23.91	**0.02**	22.63	23.67	**1.04**
8	23.90	23.90	**0.00**	23.43	23.90	**0.47**

B. Based on Max Bay Hg & Max AFCC Hg

AFCC Reach[1]	Week #2 of Initial Release[2]			End of Initial Release[3]		
	Est. Total Hg (ng/l)		Est. ? Hg (ng/l)	Est. Total Hg (ng/l)		Est. ? Hg (ng/l)
	Existing Cond.	Initial Relase Cond.		Existing Cond.	Initial Relase Cond.	
1	35.90	36.10	**0.20**	35.90	32.82	**-3.08**
2		36.32	**#VALUE!**	35.90	32.36	**-3.54**
3	35.21	35.78	**0.57**	35.50	31.46	**-4.04**
4	33.93	34.54	**0.61**	34.42	30.86	**-3.56**
5	32.43	33.08	**0.65**	33.19	30.27	**-2.92**
6	31.58	31.94	**0.36**	32.07	30.25	**-1.82**
7	31.41	31.42	**0.01**	31.49	31.12	**-0.37**
8	31.40	31.40	**0.00**	31.40	31.40	**0.00**

1 - see Figure 4 for location of AFCC reaches
2 - highest Hg concentrations occur in week #2
3 - assume max Hg concentrations predicted for continuous circulation period

Table 21. Predicted Effect of Iniital Release on Total Mercury in So. Bay near Baumberg Unit

(Conditions: Initial Release initiated April 1, salinity of discharge from Ponds 2, 2C, 10, and 8A at "proposed maximum")

A. Based on Avg Bay Hg & Avg AFCC Hg

So Bay Reach[1]	Week #2 of Initial Release[2]			End of Initial Release[3]		
	Est. Total Hg (ng/l)		Est. ? Hg (ng/l)	Est. Total Hg (ng/l)		Est. ? Hg (ng/l)
	Existing Cond.	Initial Relase Cond.		Existing Cond.	Initial Relase Cond.	
1	20.70	21.37	**0.67**	20.70	20.39	**-0.31**
2	20.70	20.91	**0.21**	20.70	20.54	**-0.16**

B. Based on Max Bay Hg & Avg AFCC Hg

AFCC Reach[1]	Week #2 of Initial Release[2]			End of Initial Release[3]		
	Est. Total Hg (ng/l)		Est. ? Hg (ng/l)	Est. Total Hg (ng/l)		Est. ? Hg (ng/l)
	Existing Cond.	Initial Relase Cond.		Existing Cond.	Initial Relase Cond.	
1	35.90	35.82	**-0.08**	35.90	34.64	**-1.26**
2	35.90	35.88	**-0.02**	35.90	35.30	**-0.60**

1 - see Figure 3 for location of South Bay reaches
2 - highest Hg concentrations occur in week #2
3 - assume ma

Figure 1. Segmentation of Alviso Slough

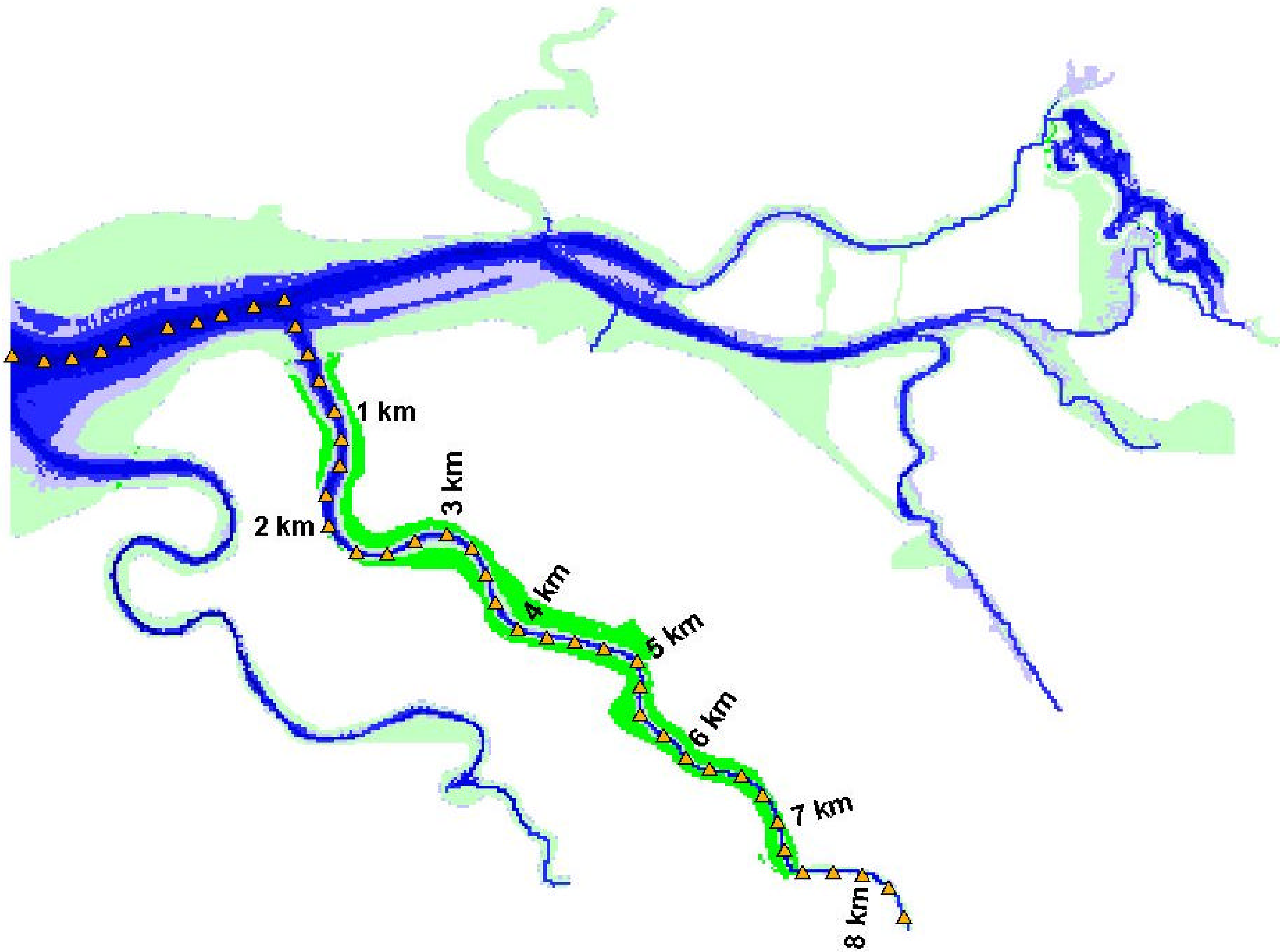


Figure 2. Segmentation of Coyote Creek & Artesian Slough

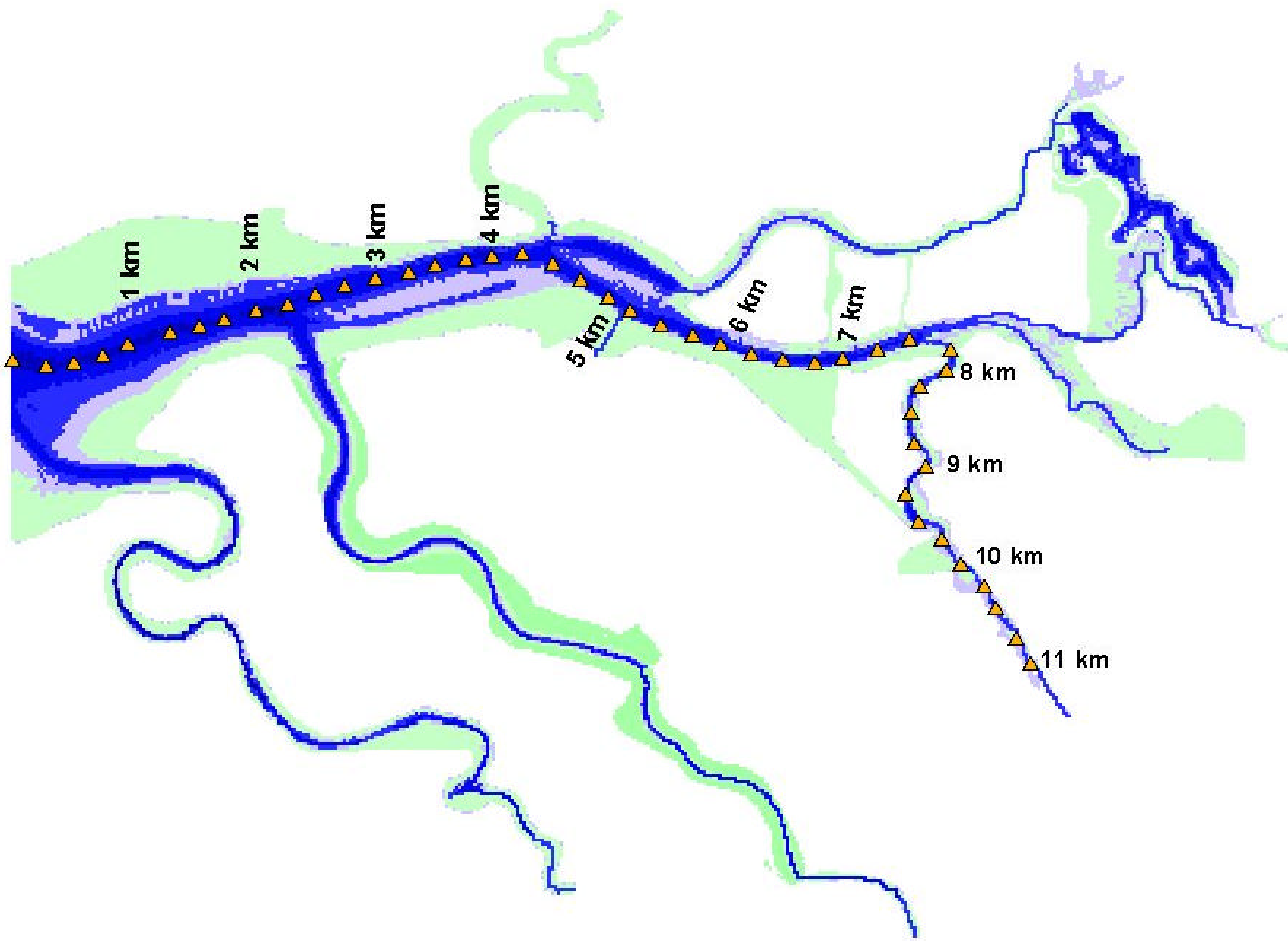


Figure 3. Segmentation of South Bay

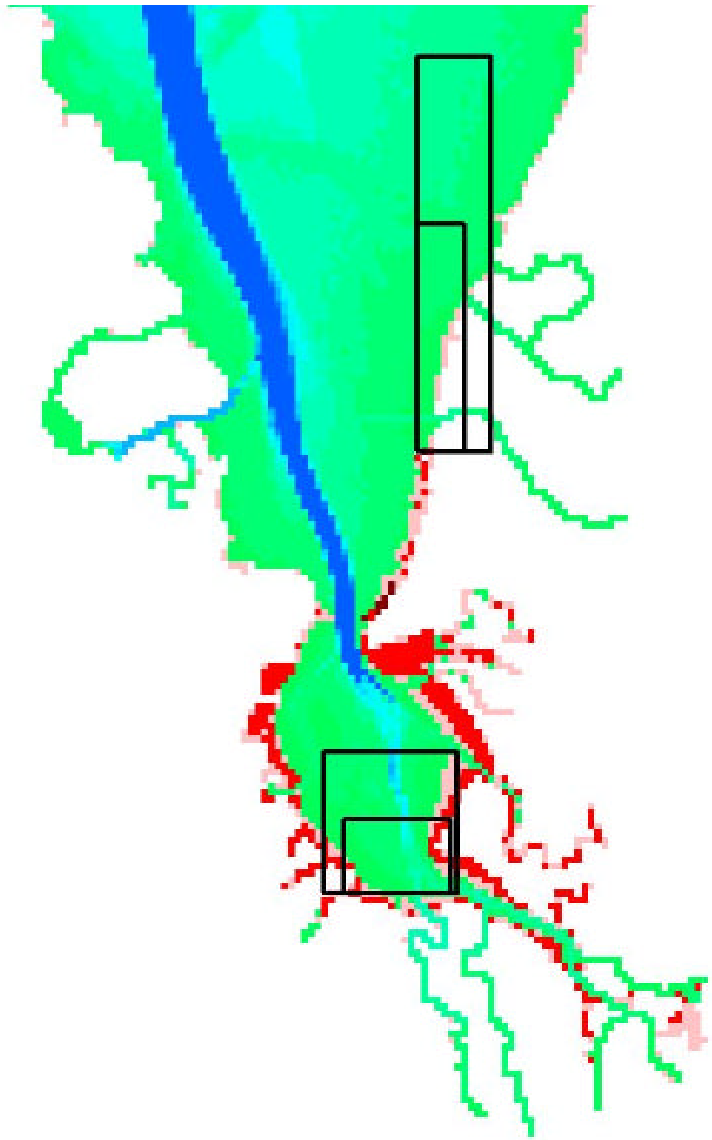


Figure 4. Segmentation of Alameda Flood Control Channel

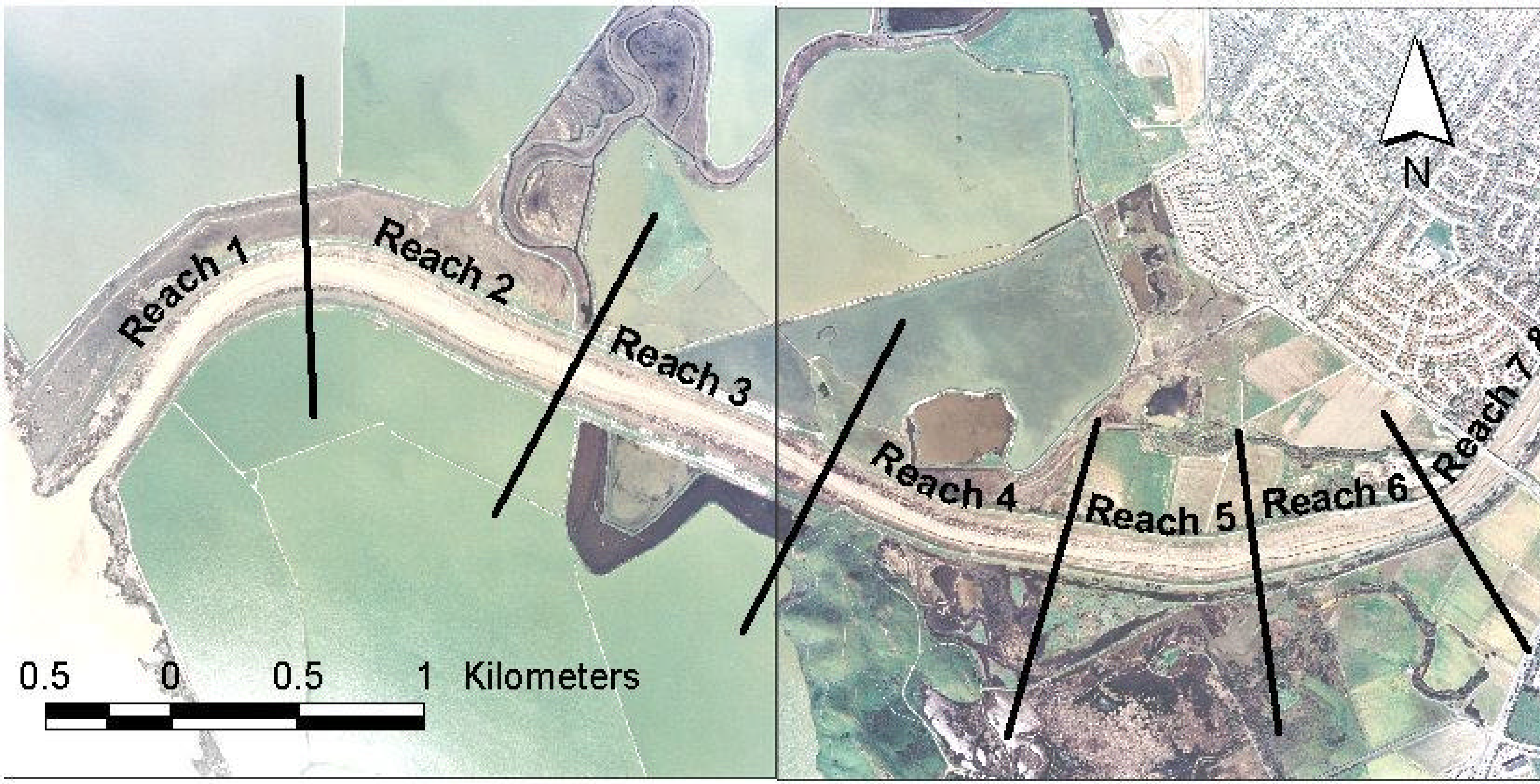
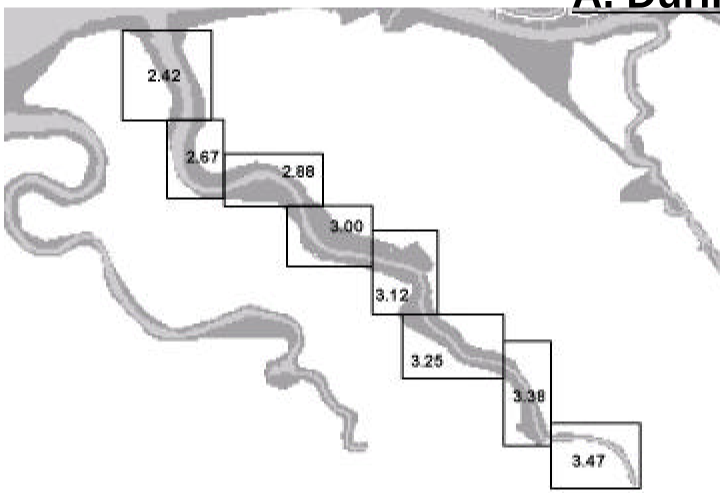
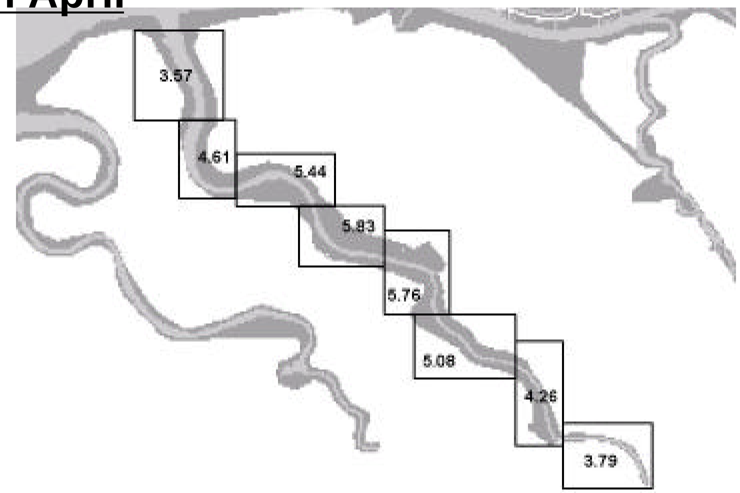


Figure 5. Predicted Dissolved Nickel Concentrations in Alviso Slough
(based on average nickel concentrations in receiving waters and Pond A7 Discharge
at Proposed Maximum Salinity)

A. During 3rd Week in April

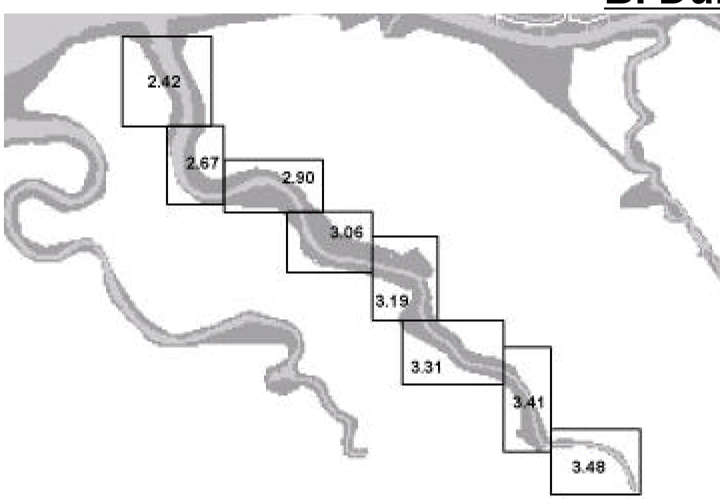


Existing Conditions (no discharge)

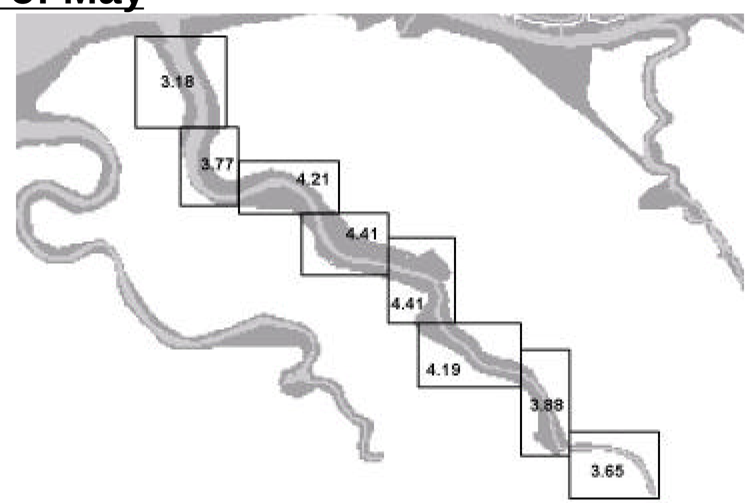


Week #3 of **Initial Release Period**

B. During 4th Week of May



Existing Conditions (no discharge)

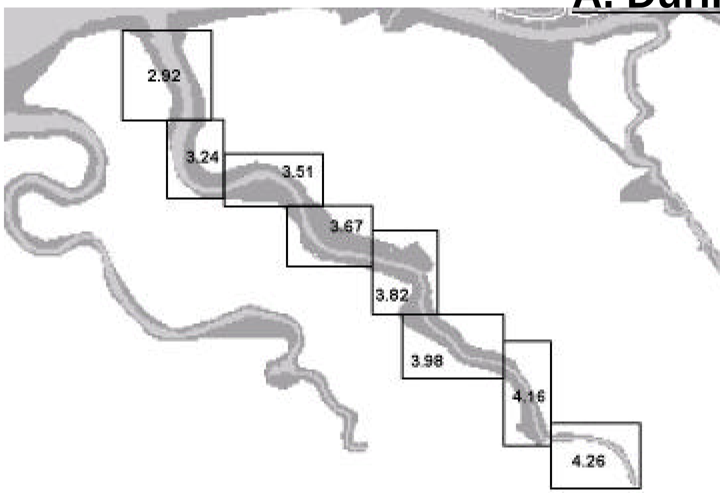


Week #8 **End of Initial Release Period**

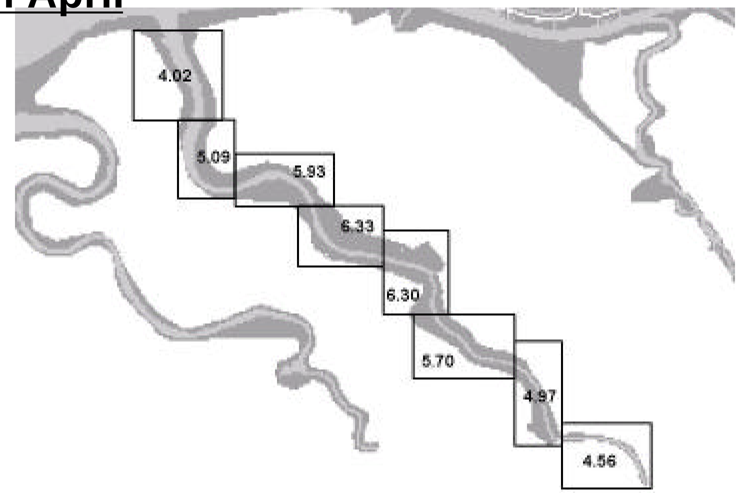
Figure 6. Predicted Dissolved Nickel Concentrations in Alviso Slough

(based on maximum nickel concentrations in receiving waters and Pond A7 Discharge at Proposed Maximum Salinity)

A. During 3rd Week in April

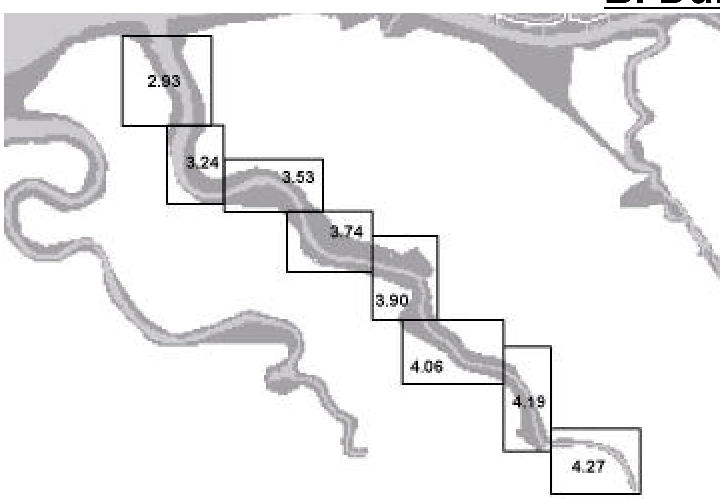


Existing Conditions (no discharge)

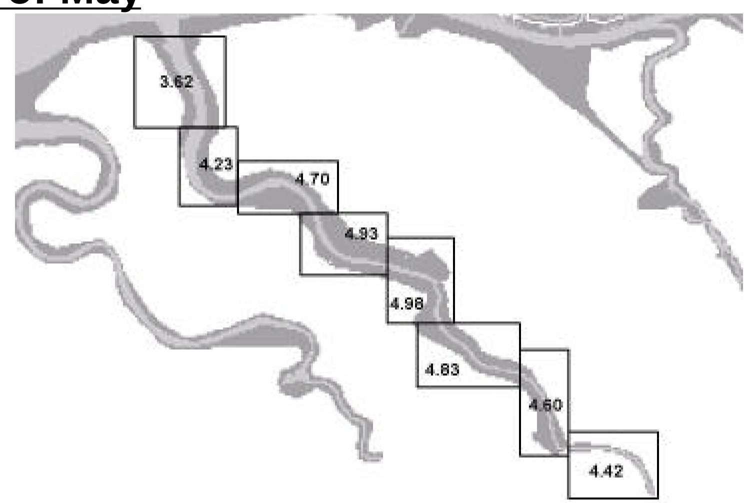


Week #3 of **Initial Release Period**

B. During 4th Week of May



Existing Conditions (no discharge)

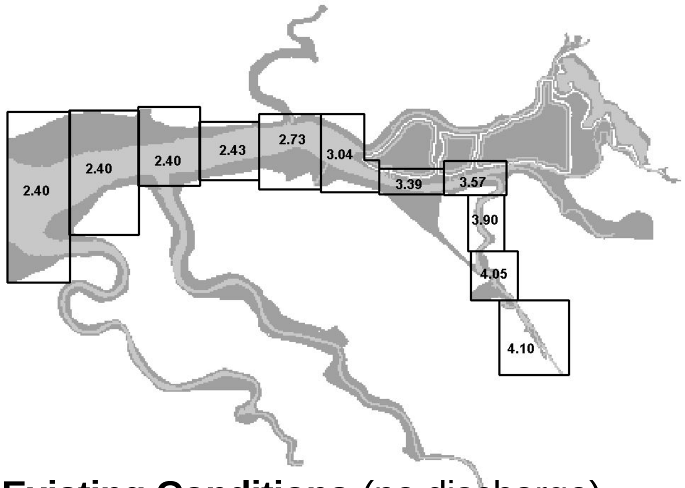


Week #8 **End of Initial Release Period**

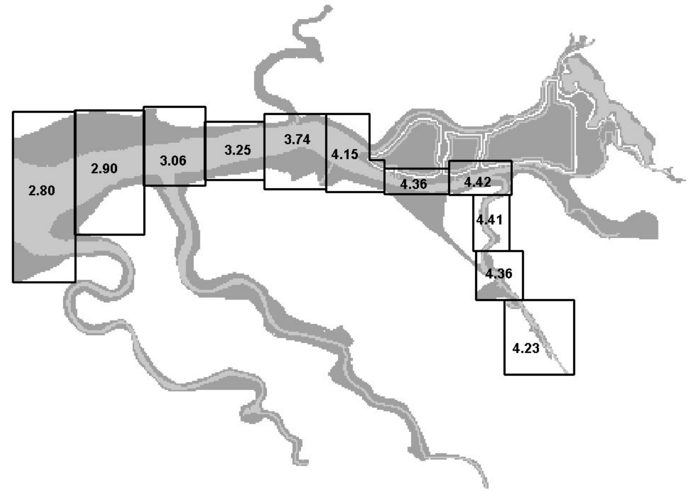
Figure 7. Predicted Dissolved Nickel Concentrations in Coyote Creek

(based on average nickel concentrations in receiving waters and Pond Discharges
at Proposed Maximum Salinities)

A. During 2nd Week in April

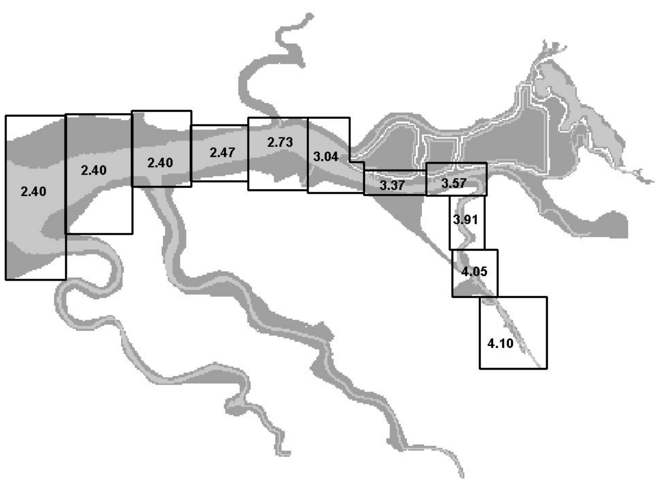


Existing Conditions (no discharge)

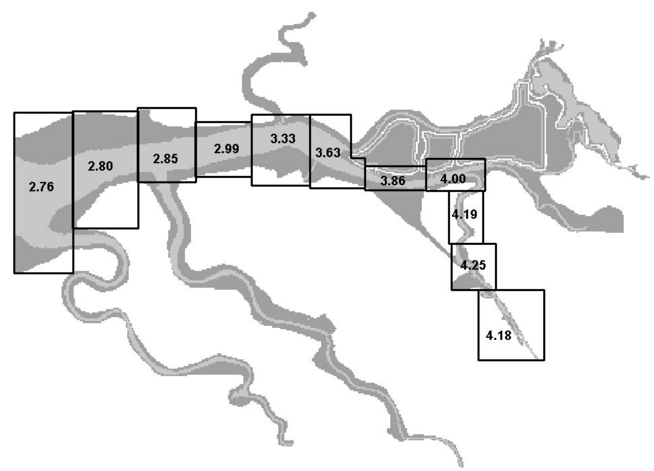


Week #2 of **Initial Release Period**

B. During 4th Week of May



Existing Conditions (no discharge)

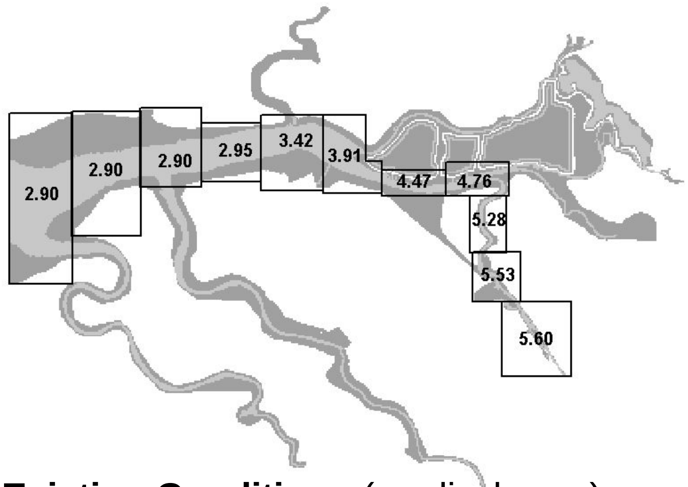


Week #8 **End of Initial Release Period**

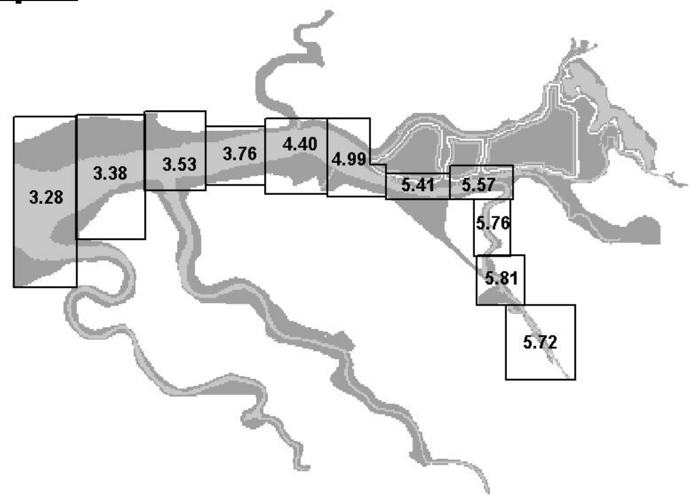
Figure 8. Predicted Dissolved Nickel Concentrations in Coyote Creek

(based on maximum nickel concentrations in receiving waters and Pond Discharges at Proposed Maximum Salinities)

A. During 2nd Week in April

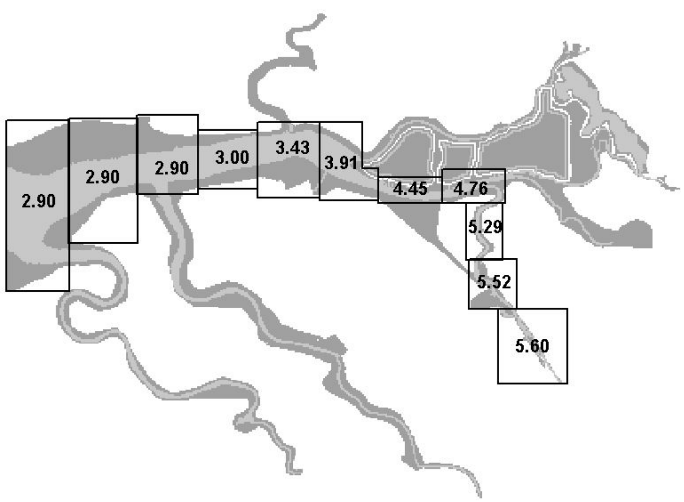


Existing Conditions (no discharge)

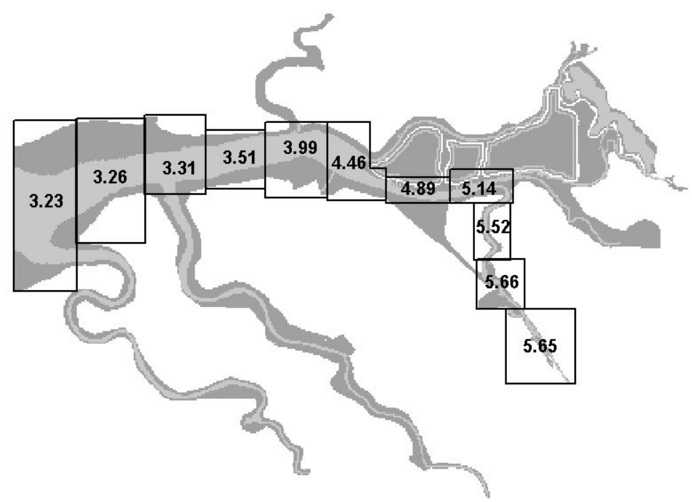


Week #2 of **Initial Release Period**

B. During 4th Week of May



Existing Conditions (no discharge)

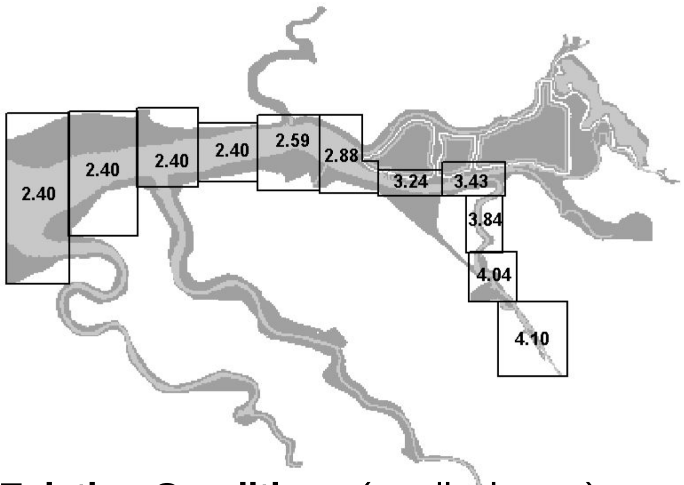


Week #8 **End of Initial Release Period**

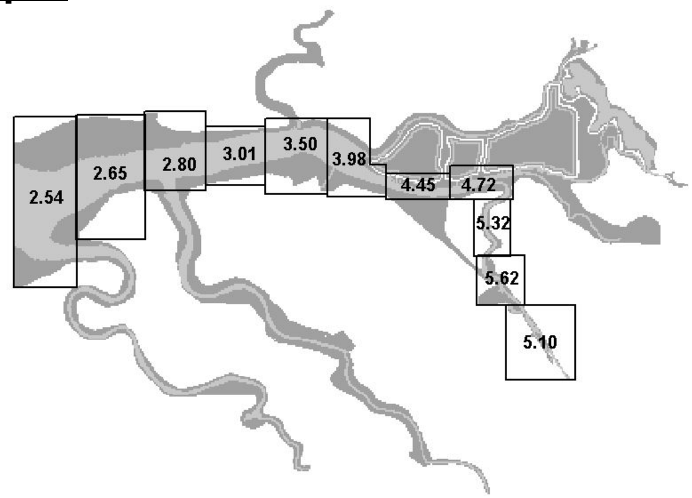
Figure 9. Predicted Dissolved Nickel Concentrations in Coyote Creek

(based on average nickel concentrations in receiving waters and Pond Discharges at Proposed Maximum Salinities)

A. During 1st Week in April

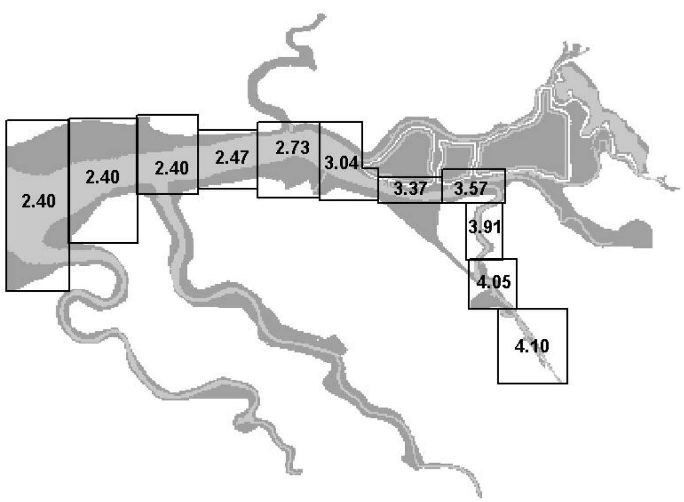


Existing Conditions (no discharge)

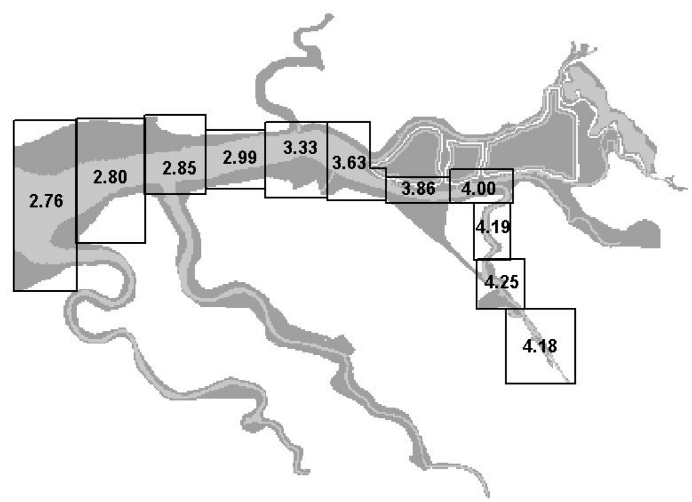


Week #1 of **Initial Release Period**

B. During 4th Week of May



Existing Conditions (no discharge)

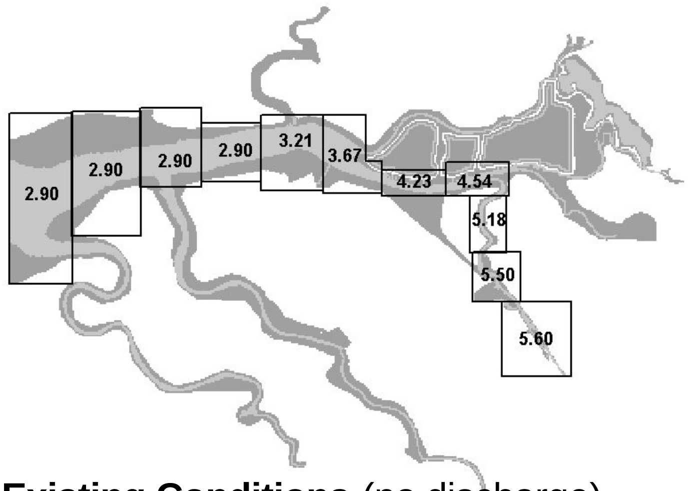


Week #8 **End of Initial Release Period**

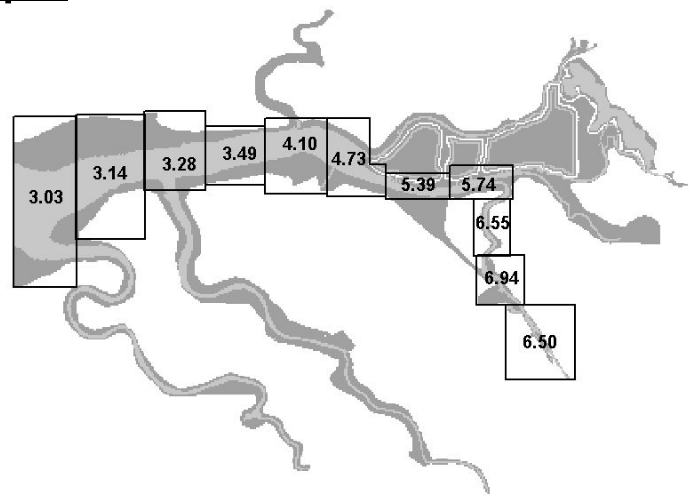
Figure 10. Predicted Dissolved Nickel Concentrations in Coyote Creek

(based on maximum nickel concentrations in receiving waters and Pond Discharges at Proposed Maximum Salinities)

A. During 1st Week in April

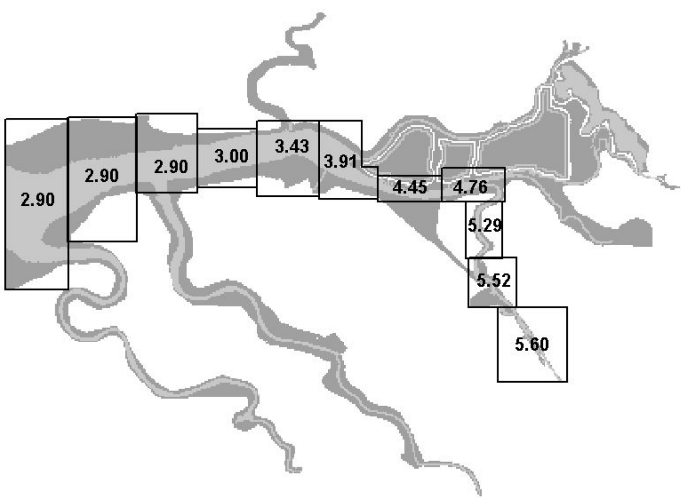


Existing Conditions (no discharge)

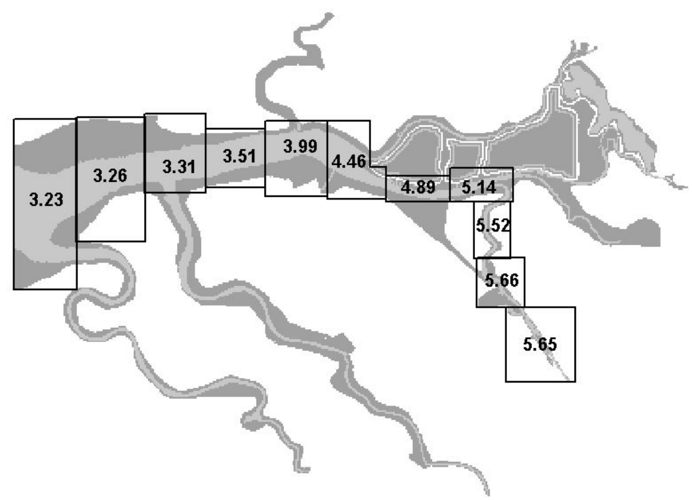


Week #1 of **Initial Release Period**

B. During 4th Week of May



Existing Conditions (no discharge)

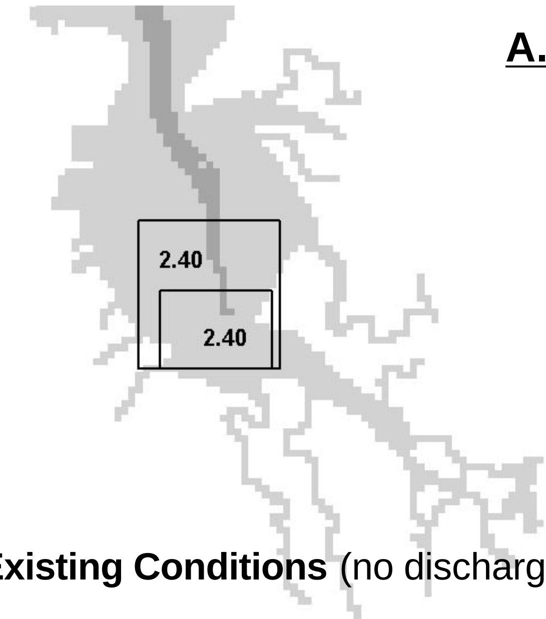


Week #8 **End of Initial Release Period**

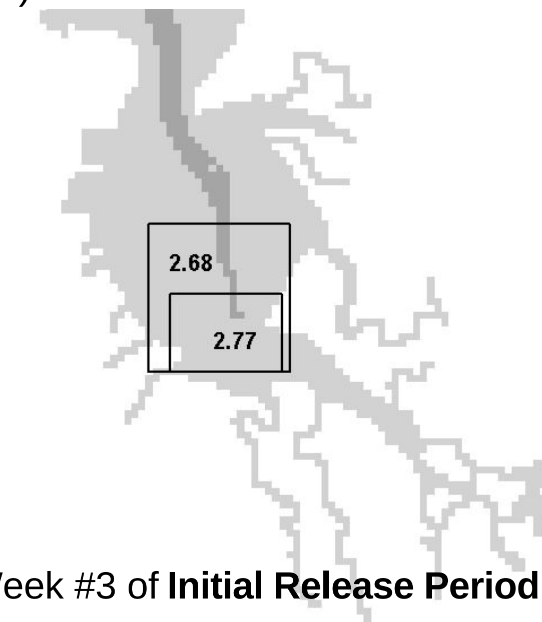
Figure 11. Predicted Dissolved Nickel Concentrations in South Bay

(based on average nickel concentrations in receiving waters and Pond Discharges at Proposed Maximum Salinities)

A. During 3rd Week in April

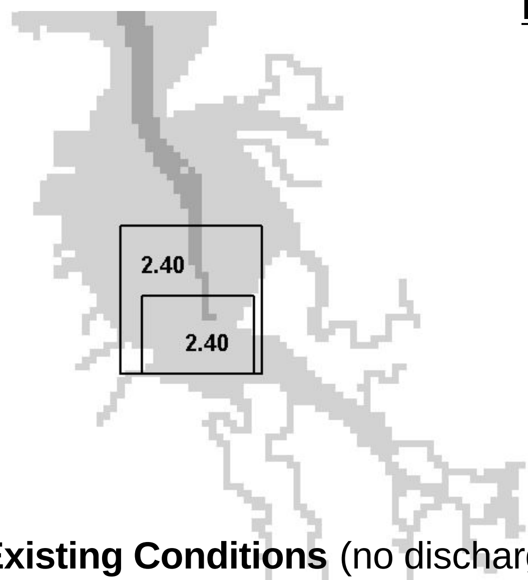


Existing Conditions (no discharge)

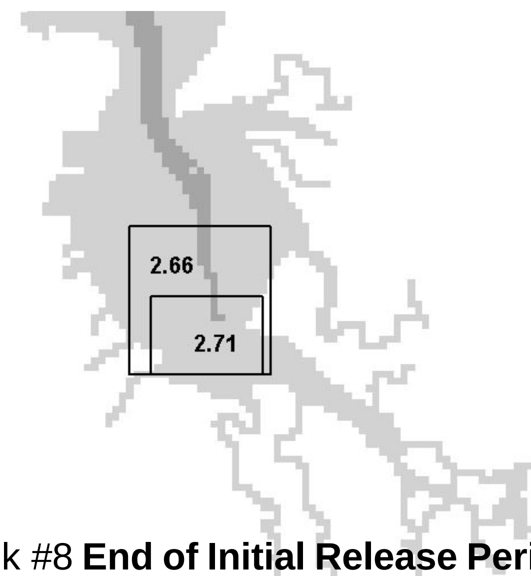


Week #3 of **Initial Release Period**

B. During 4th Week of May



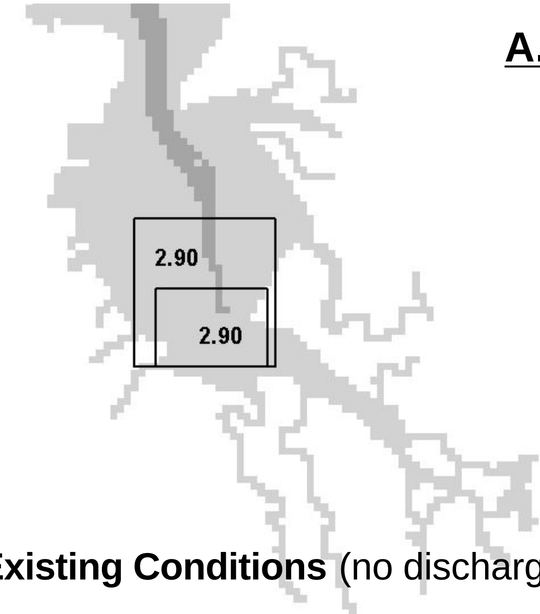
Existing Conditions (no discharge)



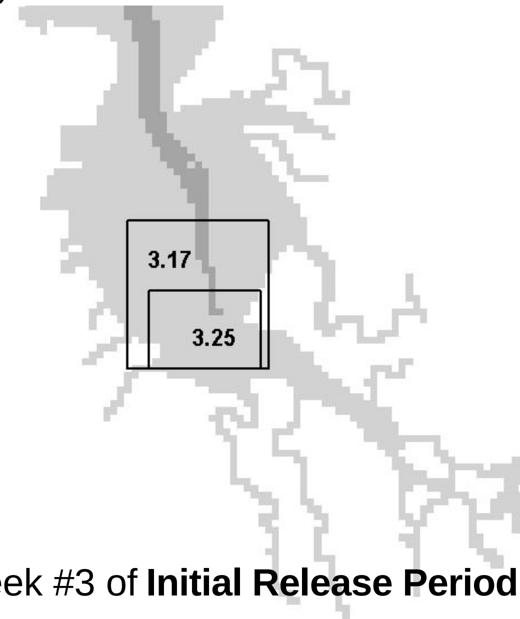
Week #8 **End of Initial Release Period**

Figure 12. Predicted Dissolved Nickel Concentrations in South Bay
(based on maximum nickel concentrations in receiving waters and Pond Discharges at Proposed Maximum Salinities)

<u>A. During 3rd Week in April</u>

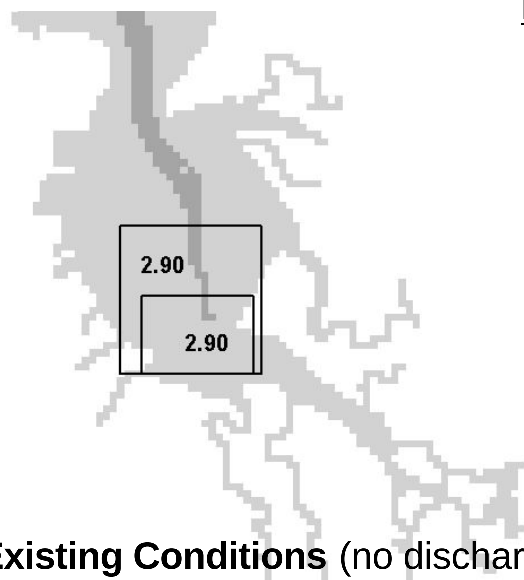


Existing Conditions (no discharge)

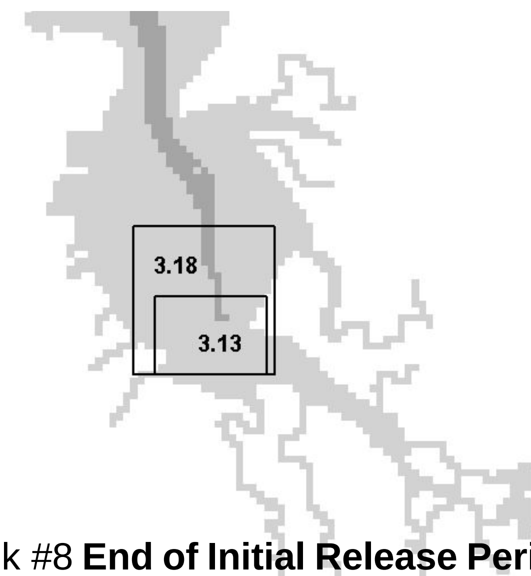


Week #3 of **Initial Release Period**

<u>B. During 4th Week of May</u>



Existing Conditions (no discharge)

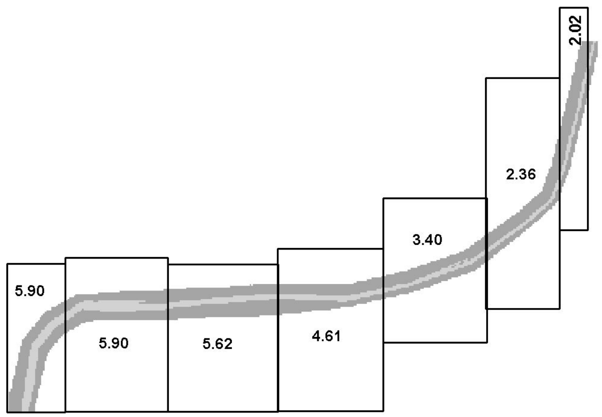


Week #8 **End of Initial Release Period**

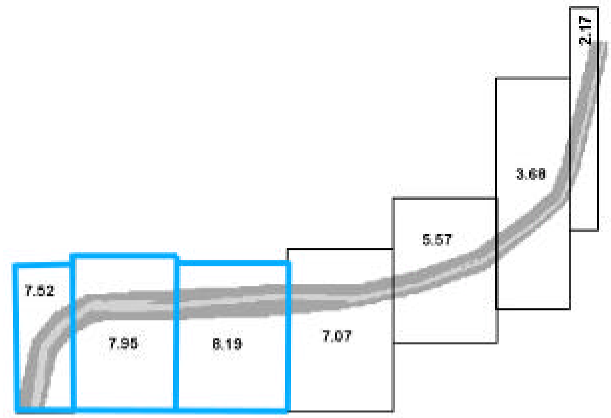
Figure 13. Predicted Total Nickel Concentrations in AFCC

(based on average nickel concentrations in receiving waters and Pond 2C Discharge at Proposed Maximum Salinity)

A. During 1st Week in May

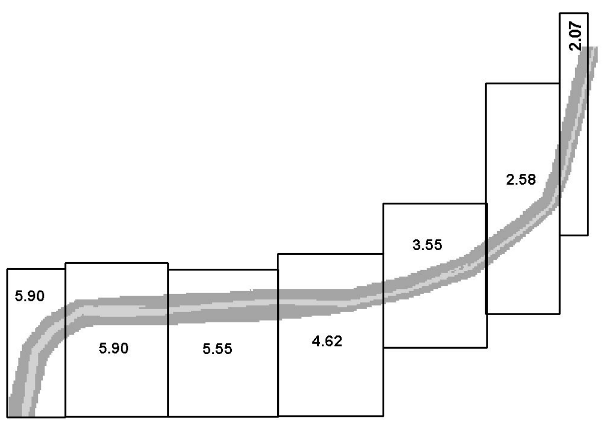


Existing Conditions (no discharge)

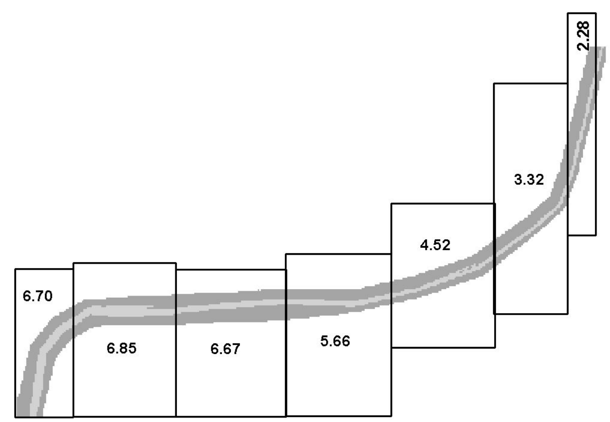


Week #5 of **Initial Release Period**

B. During 4th Week of May



Existing Conditions (no discharge)

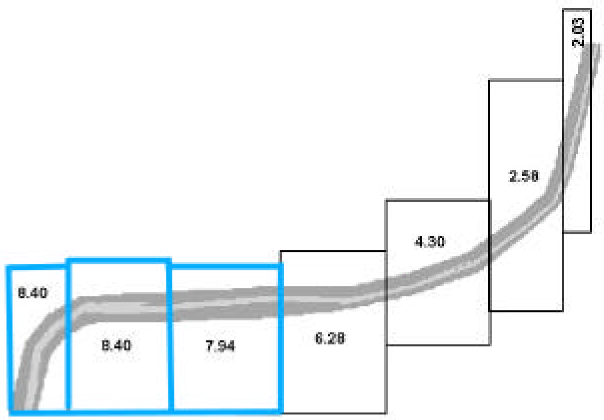


Week #8 **End of Initial Release Period**

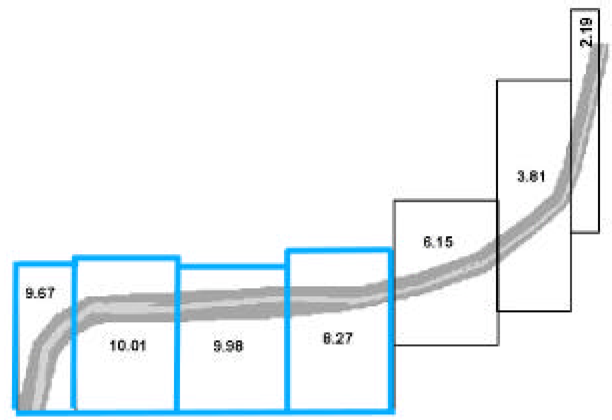
Figure 14. Predicted Total Nickel Concentrations in AFCC

(based on maximum nickel concentrations in bay & average nickel concentrations in AFCC and Pond 2C Discharge at Proposed Maximum Salinity)

A. During 1st Week in May

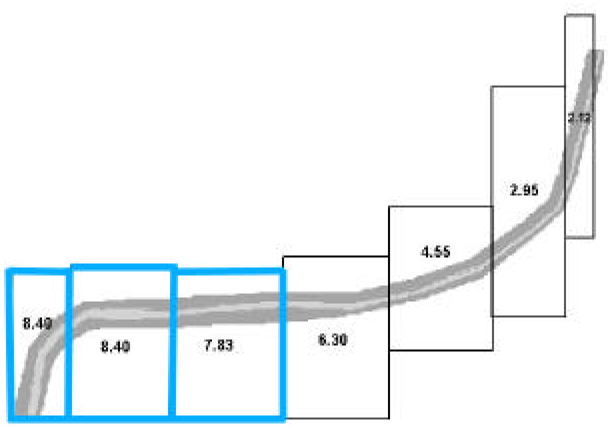


Existing Conditions (no discharge)

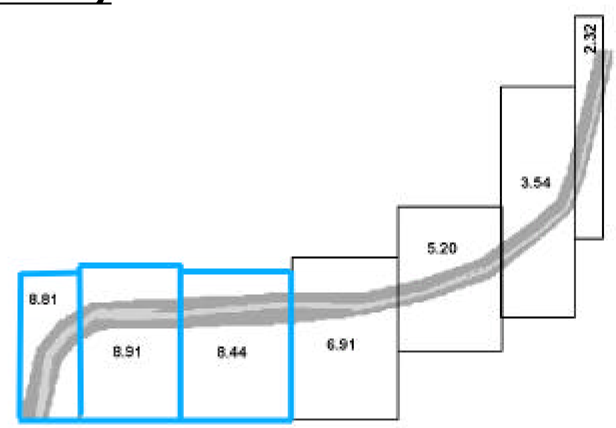


Week #5 of **Initial Release Period**

B. During 4th Week of May



Existing Conditions (no discharge)

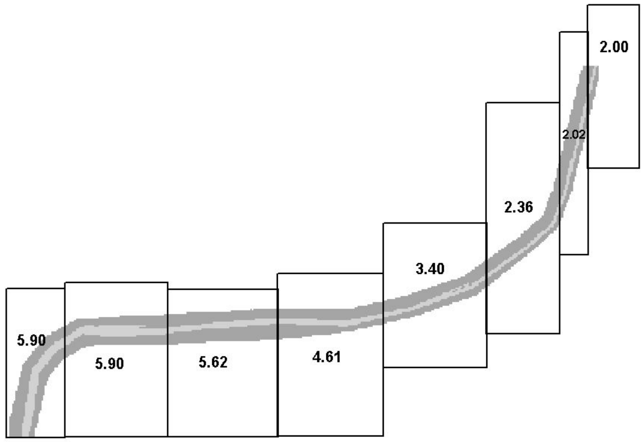


Week #8 **End of Initial Release Period**

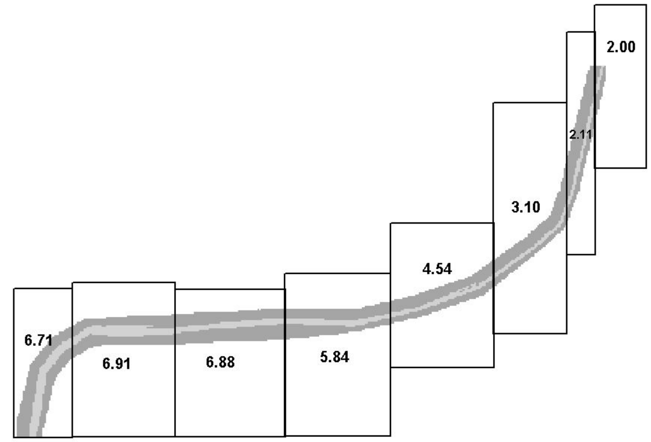
Figure 15. Predicted Total Nickel Concentrations in AFCC

(based on average nickel concentrations in receiving waters and Pond 2C Discharge at 2002 Salinity Values)

A. During 1st Week in May

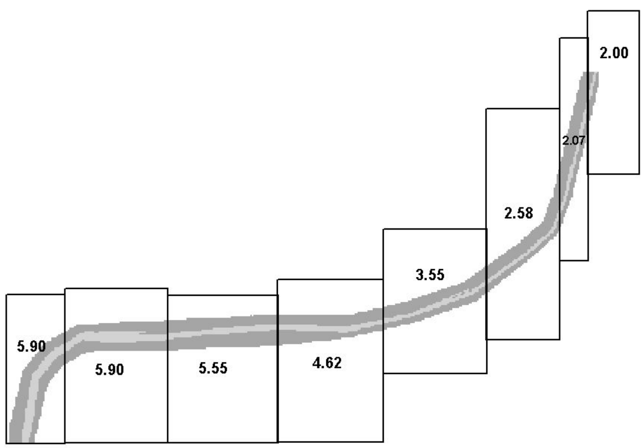


Existing Conditions (no discharge)

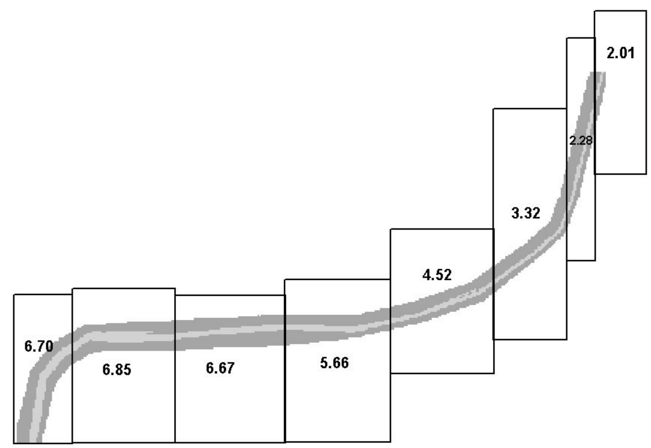


Week #5 of **Initial Release Period**

B. During 4th Week of May



Existing Conditions (no discharge)

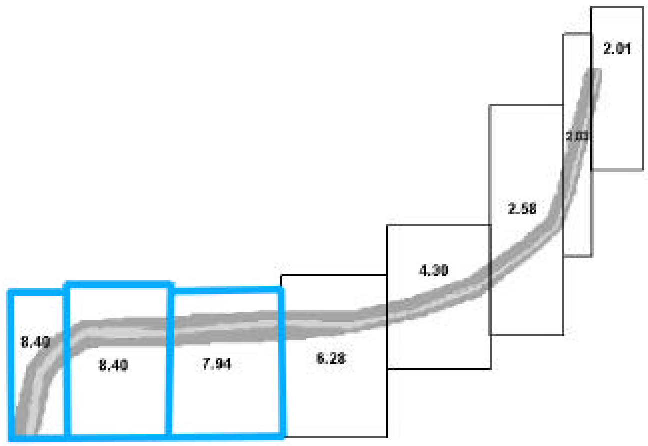


Week #8 **End of Initial Release Period**

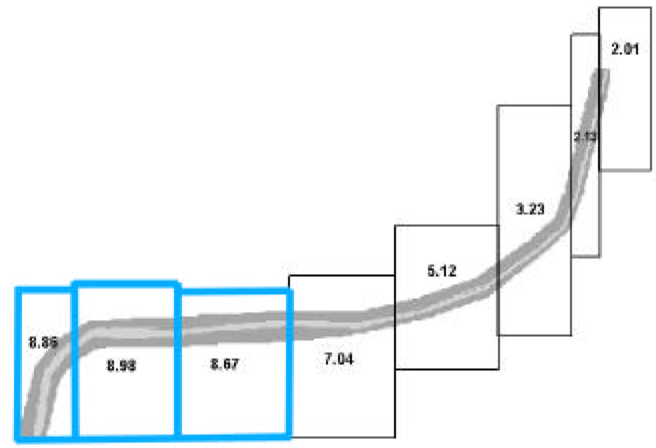
Figure 16. Predicted Total Nickel Concentrations in AFCC

(based on maximum nickel concentrations in bay & average nickel concentrations in AFCC and Pond 2C Discharge at 2002 Salinity Values)

A. During 1st Week in May

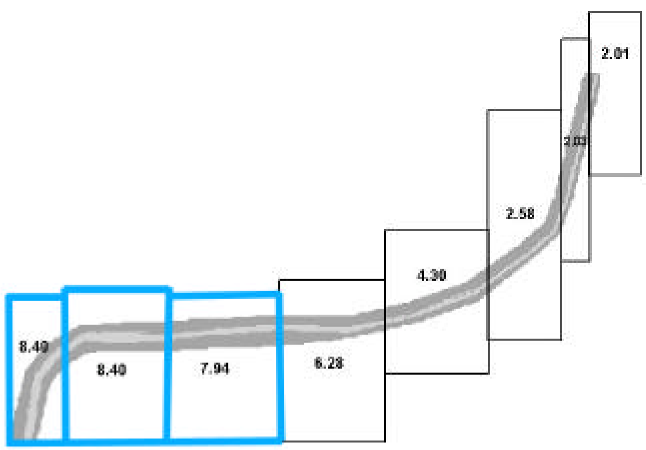


Existing Conditions (no discharge)

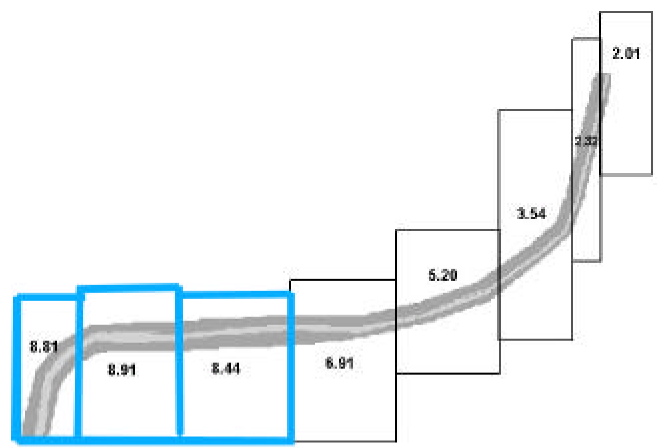


Week #5 of **Initial Release Period**

B. During 4th Week of May



Existing Conditions (no discharge)

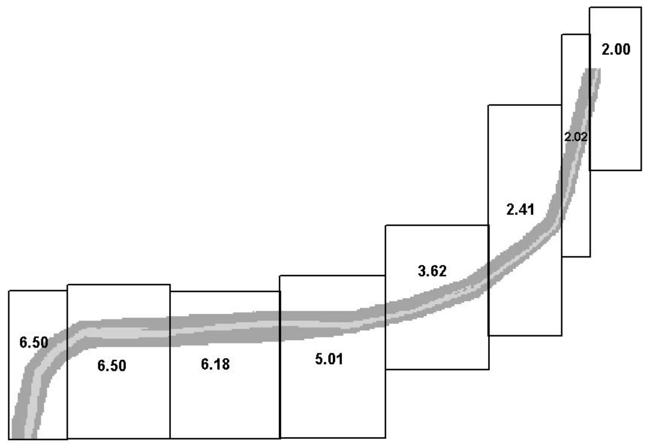


Week #8 **End of Initial Release Period**

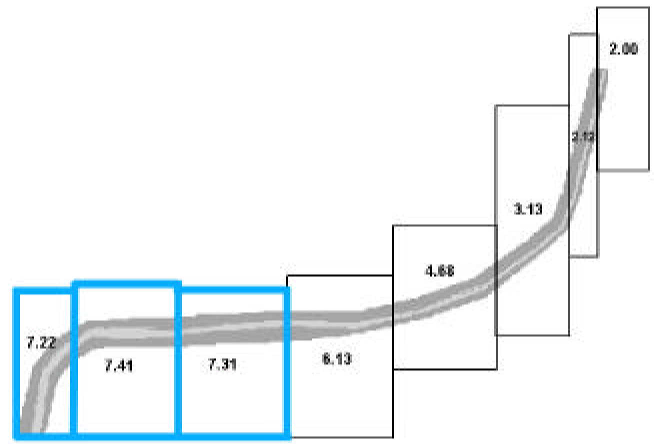
Figure 17. Predicted Total Nickel Concentrations in AFCC

(based on average nickel concentrations in receiving waters and Pond 2C Discharge at Continuous Circulation Salinities)

A. During 1st Week in May

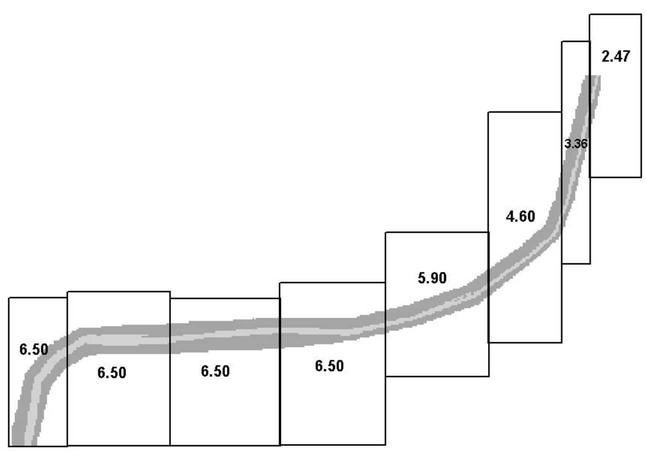


Existing Conditions (no discharge)

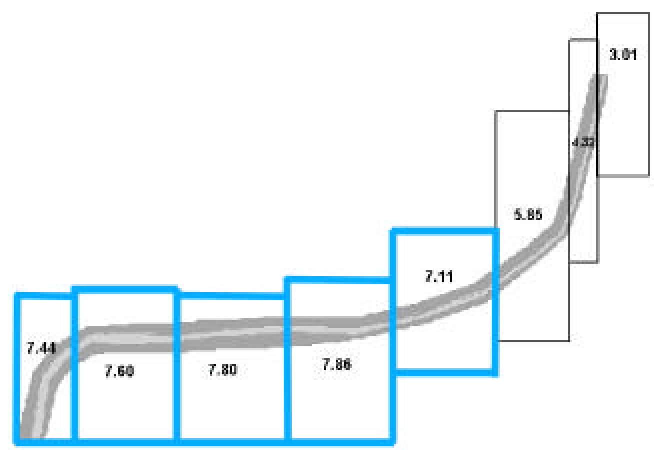


Continuous Circulation Period

B. During 2nd Week of September



Existing Conditions (no discharge)

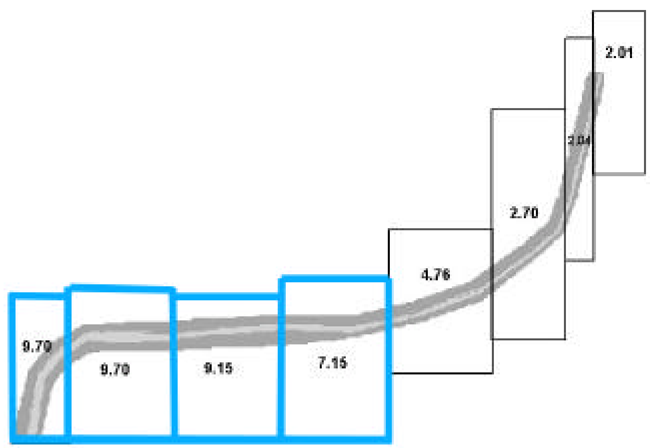


Continuous Circulation Period

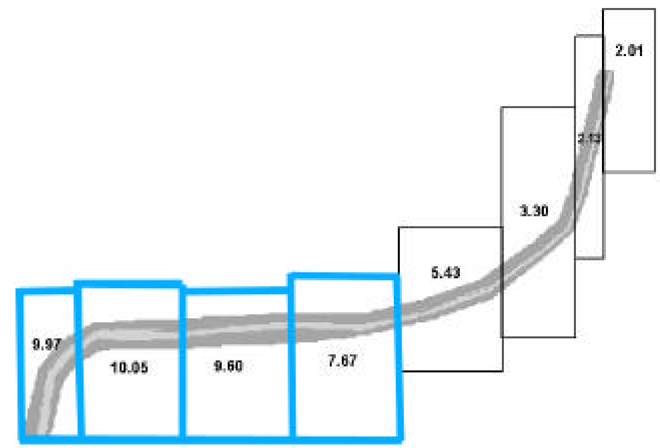
Figure 18. Predicted Total Nickel Concentrations in AFCC

(based on maximum nickel concentrations in bay & average nickel concentrations in AFCC and Pond 2C Discharge at Continuous Circulation Salinities)

A. During 1st Week in May

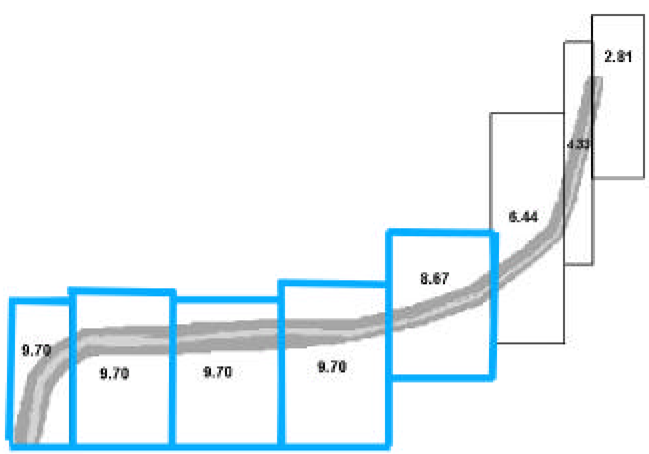


Existing Conditions (no discharge)

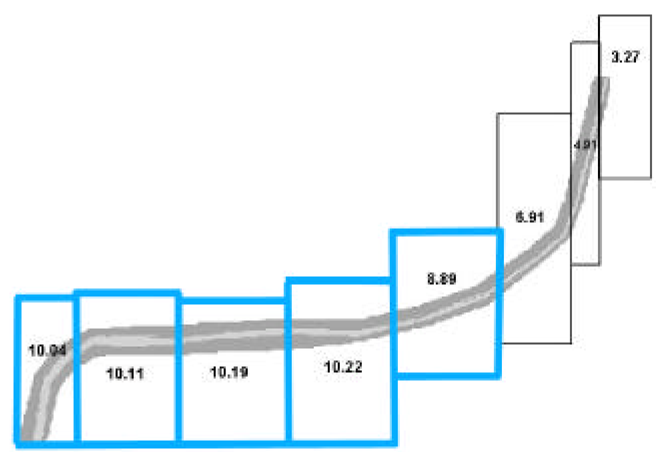


Continuous Circulation Period

B. During 2nd Week of September



Existing Conditions (no discharge)

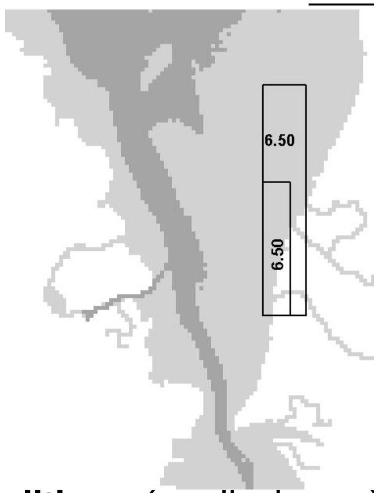


Continuous Circulation Period

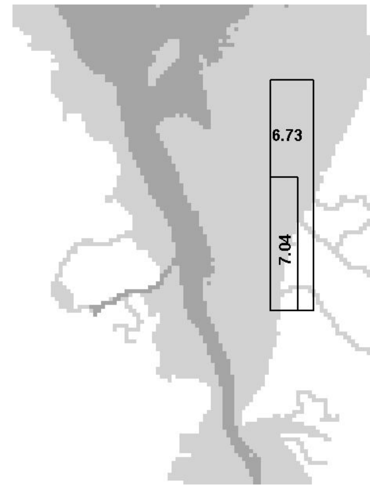
Figure 19. Predicted Total Nickel Concentrations in South Bay

(based on average nickel concentrations in receiving waters and Pond Discharges at Proposed Maximum Salinities)

A. During 2nd Week in May

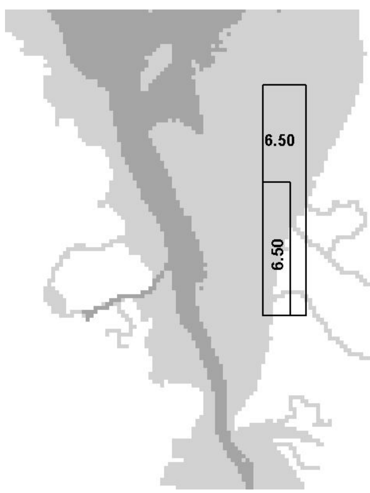


Existing Conditions (no discharge)

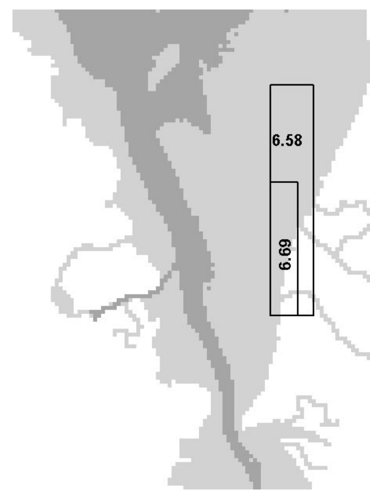


Week #6 of **Initial Release Period**

B. During 4th Week of May



Existing Conditions (no discharge)

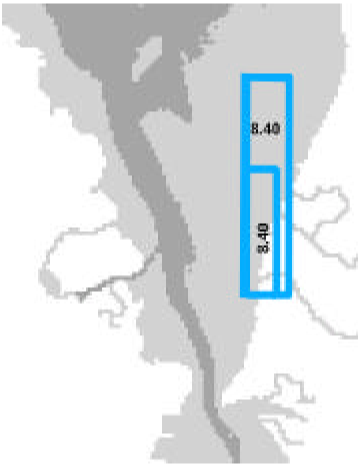


Week #8 **End of Initial Release Period**

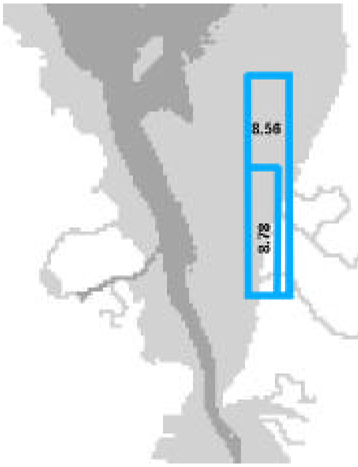
Figure 20. Predicted Total Nickel Concentrations in South Bay

(based on maximum nickel concentrations in bay & average nickel concentrations in AFCC and Pond Discharges at Proposed Maximum Salinities)

A. During 2nd Week in May

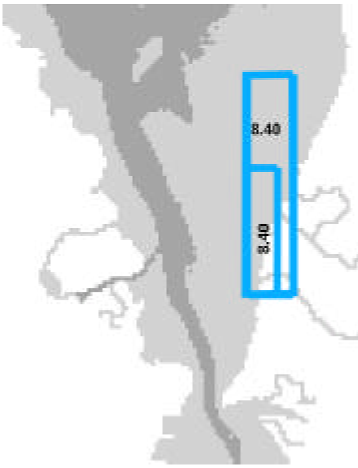


Existing Conditions (no discharge)

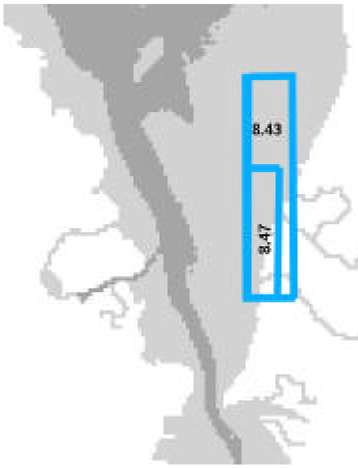


Week #6 of **Initial Release Period**

B. During 4th Week of May



Existing Conditions (no discharge)

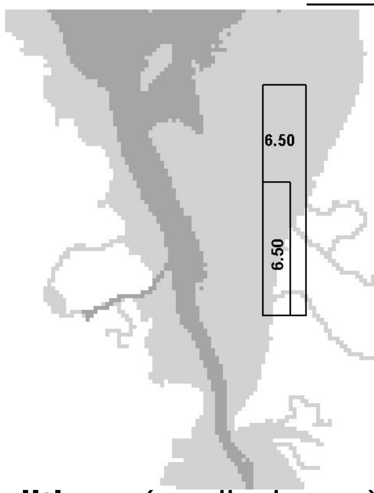


Week #8 **End of Initial Release Period**

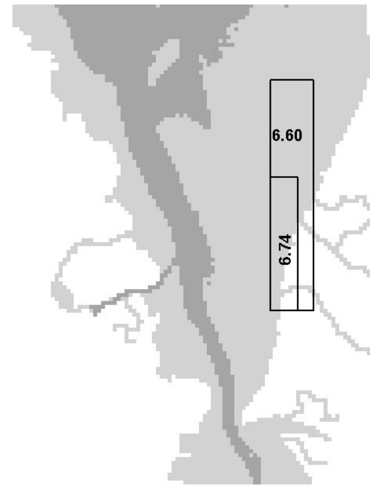
Figure 21. Predicted Total Nickel Concentrations in South Bay

(based on average nickel concentrations in receiving waters and Pond Discharges at 2002 Salinity Values)

A. During 2nd Week in May

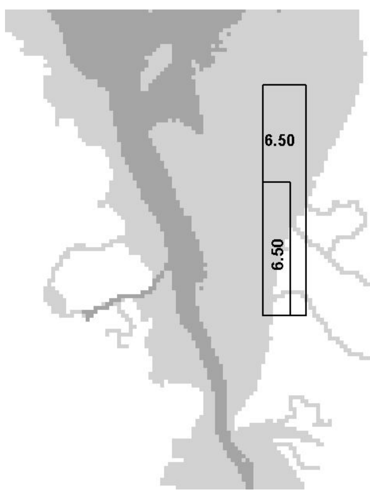


Existing Conditions (no discharge)

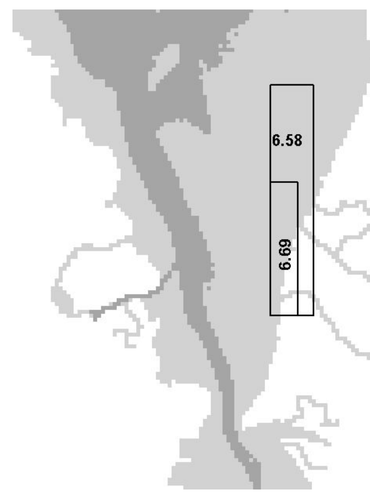


Week #6 of **Initial Release Period**

B. During 4th Week of May



Existing Conditions (no discharge)

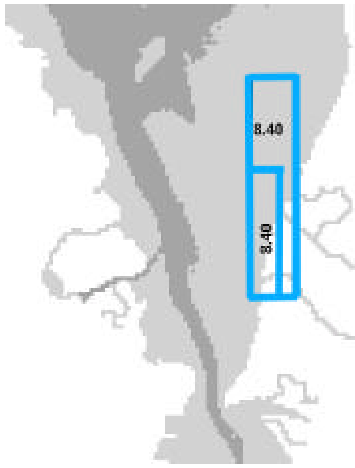


Week #8 **End of Initial Release Period**

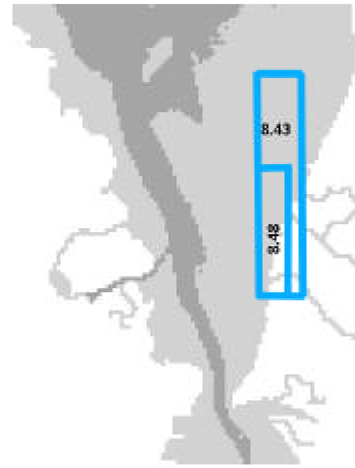
Figure 22. Predicted Total Nickel Concentrations in South Bay

(based on maximum nickel concentrations in bay & average nickel concentrations in AFCC and Pond Discharges at 2002 Salinity Values)

A. During 2nd Week in May

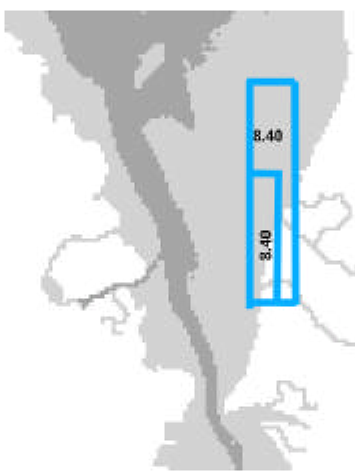


Existing Conditions (no discharge)

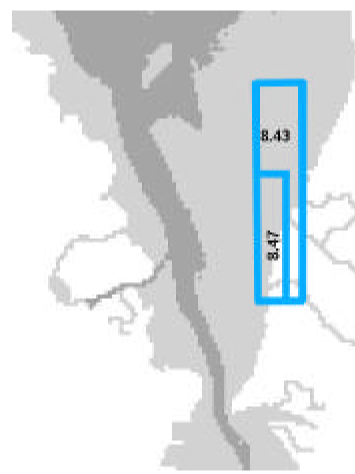


Week #6 of **Initial Release Period**

B. During 4th Week of May



Existing Conditions (no discharge)

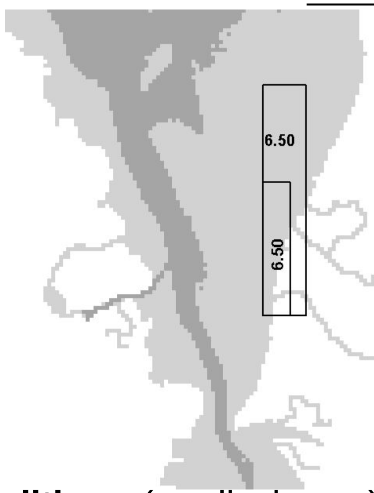


Week #8 **End of Initial Release Period**

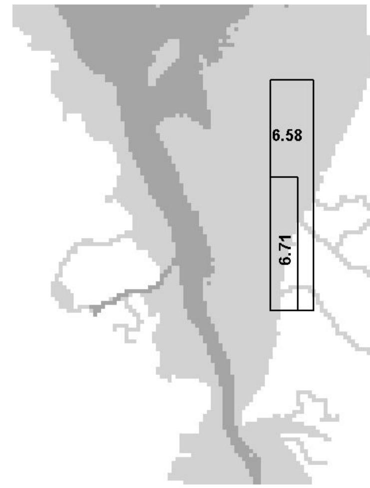
Figure 23. Predicted Total Nickel Concentrations in South Bay

(based on average nickel concentrations in receiving waters and Pond Discharges at Continuous Circulation Values)

A. During 1st Week in May

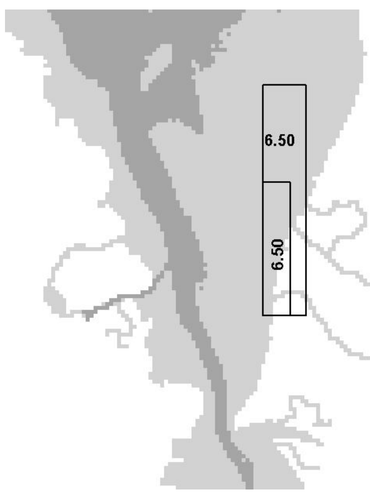


Existing Conditions (no discharge)

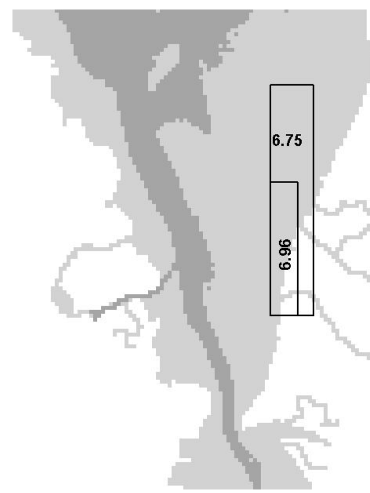


Continuous Circulation Period

B. During 2nd Week of September



Existing Conditions (no discharge)

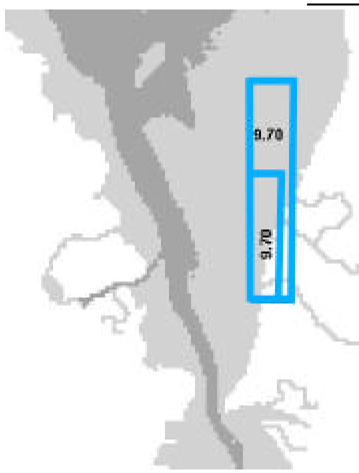


Continuous Circulation Period

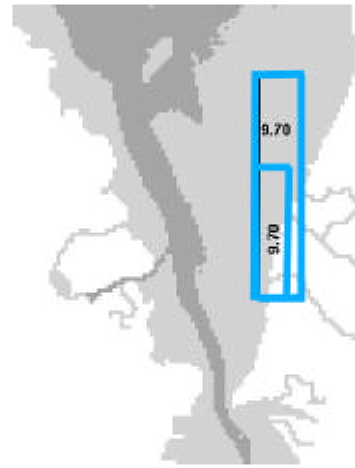
Figure 24. Predicted Total Nickel Concentrations in South Bay

(based on maximum nickel concentrations in bay & average nickel concentrations in AFCC and Pond Discharges at Continuous Circulation Values)

A. During 1st Week in May

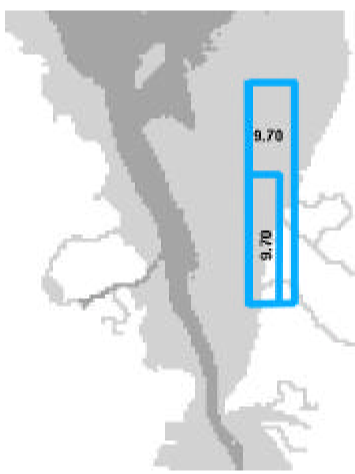


Existing Conditions (no discharge)

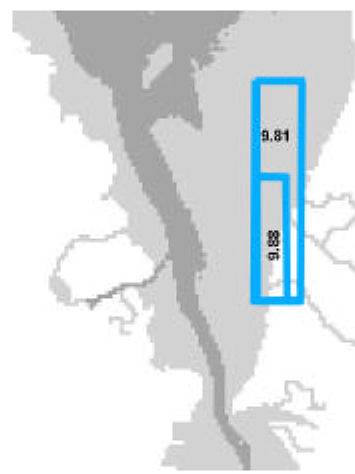


Continuous Circulation Period

B. During 2nd Week of September



Existing Conditions (no discharge)

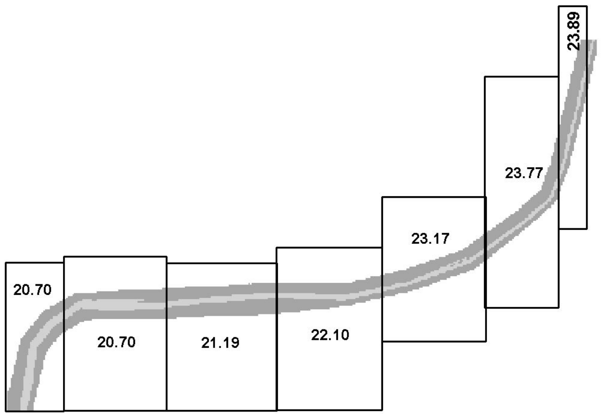


Continuous Circulation Period

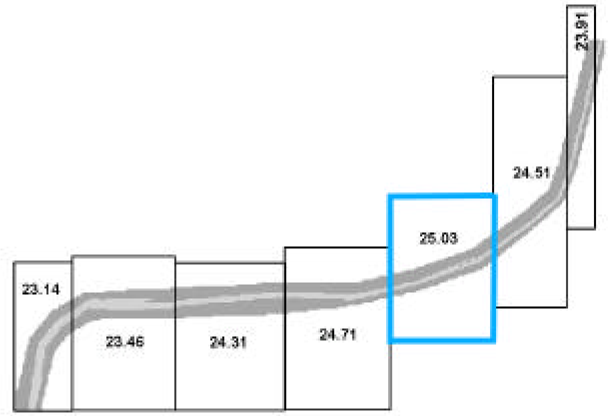
Figure 25. Predicted Total Mercury Concentrations in AFCC

(based on average mercury concentrations in receiving waters and Pond 2C Discharge at Proposed Maximum Salinity)

<u>A. During 2nd Week in April</u>

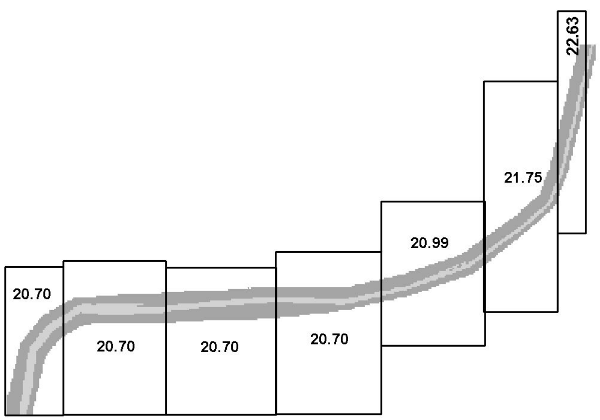


Existing Conditions (no discharge)

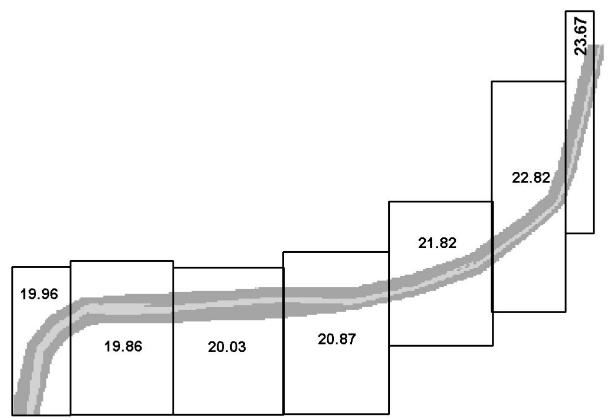


Week #5 of **Initial Release Period**

<u>B. During 4th Week of May</u>



Existing Conditions (no discharge)

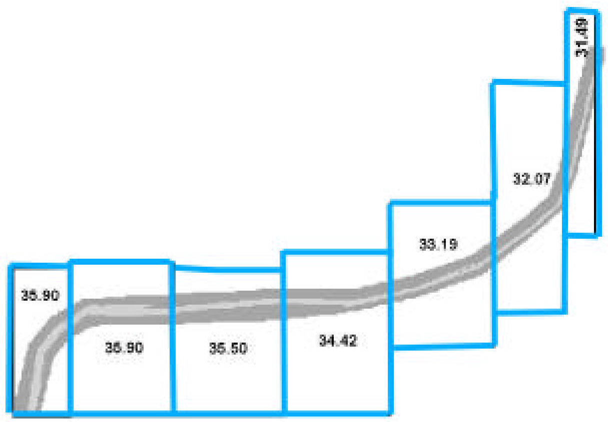


Week #8 **End of Initial Release Period**

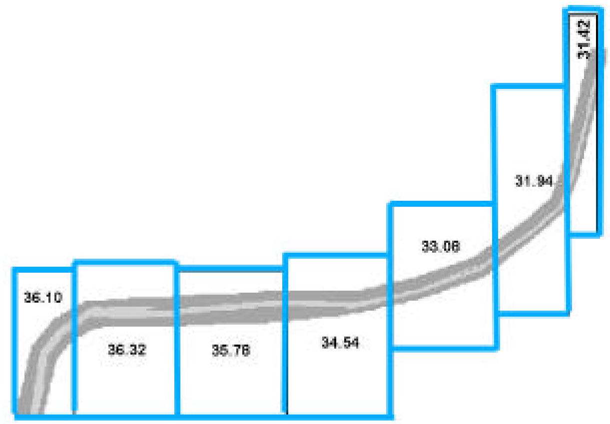
Figure 26. Predicted Total Mercury Concentrations in AFCC

(based on maximum mercury concentrations in receiving waters and Pond 2C Discharge at Proposed Maximum Salinity)

A. During 2nd Week in April

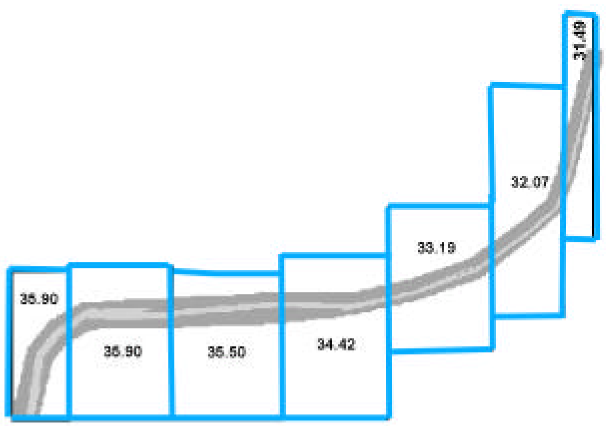


Existing Conditions (no discharge)

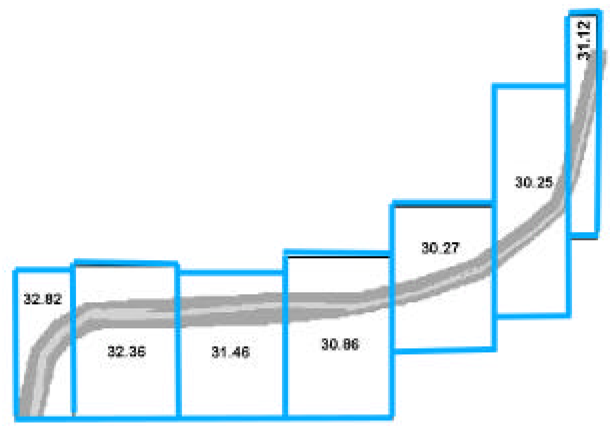


Week #5 of **Initial Release Period**

B. During 4th Week of May



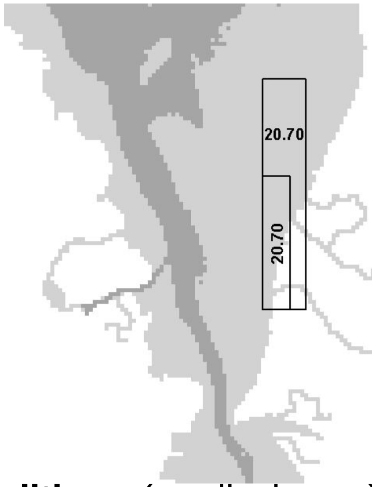
Existing Conditions (no discharge)



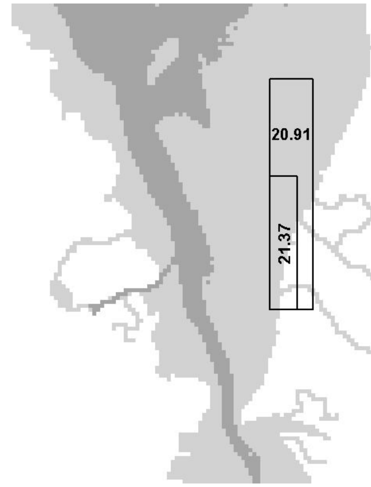
Week #8 **End of Initial Release Period**

Figure 27. Predicted Total Mercury Concentrations in South Bay
(based on average mercury concentrations in receiving waters and Pond Discharges at Proposed Maximum Salinity)

A. During 2nd Week in April

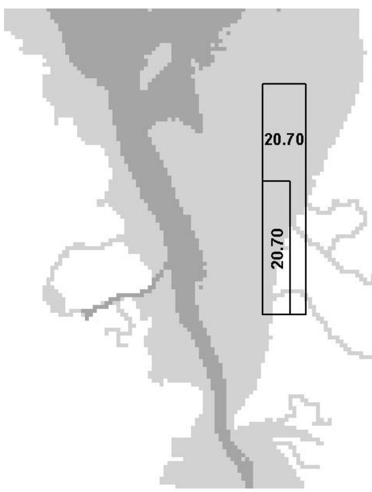


Existing Conditions (no discharge)

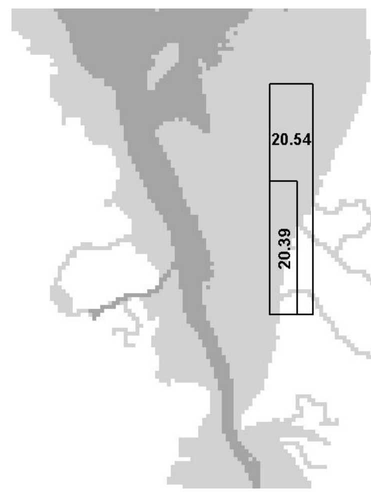


Week #2 of **Initial Release Period**

B. During 4th Week of May



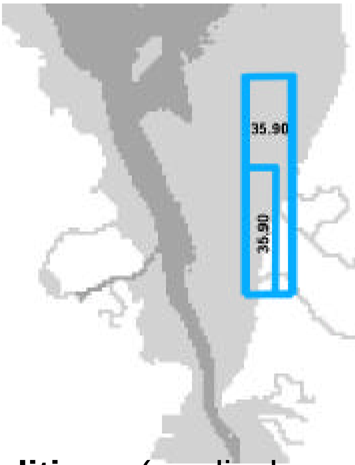
Existing Conditions (no discharge)



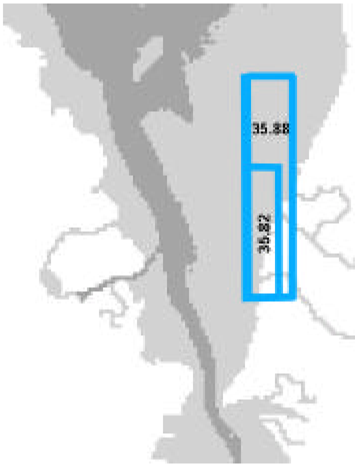
Week #8 **End of Initial Release Period**

Figure 28. Predicted Total Mercury Concentrations in South Bay
(based on maximum mercury concentrations in bay & average mercury concentrations in AFCC and Pond Discharges at Proposed Maximum Salinity)

A. During 2nd Week in April

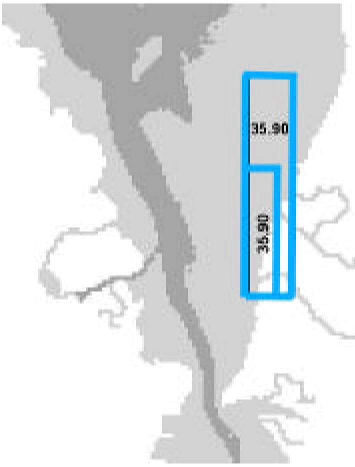


Existing Conditions (no discharge)

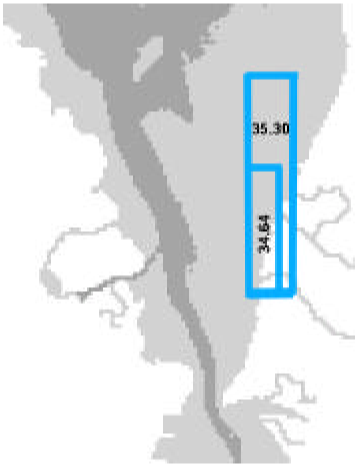


Week #2 of **Initial Release Period**

B. During 4th Week of May



Existing Conditions (no discharge)



Week #8 **End of Initial Release Period**

Report 6/903

EVALUATION OF THE POTENTIAL FOR IMPACTS TO AQUATIC LIFE DUE TO THE ELEVATED SALINITY OF POND WATER CIRCULATED DURING THE INITIAL STEWARDSHIP PERIOD

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1. OVERVIEW

During the Initial Stewardship Period, the salinity of the discharges from the Alviso Unit, Baumberg Unit, and West Bay Unit ponds will generally be greater than the salinity of the receiving waters. The greatest differences in salinity between discharge and receiving water will occur during the Initial Release Period, when the highest salinity waters (estimated to be as high as 135 ppt) will be pushed out of the ponds. After this Initial Release Period, which is expected to last approximately two months, bay water will be continuously circulated through the ponds so that pond salinities are maintained at levels suitable for future restoration. During the Continuous Circulation Period, the discharge salinities may be as high as 44 ppt.

Based on discussions with staffs of the San Francisco Regional Water Quality Control Board, California Department of Fish and Game, and the U.S. Fish and Wildlife Service, the elevated salinity of these pond waters which would be circulated into receiving water bodies in the South Bay (i.e., segments of the bay proper and adjoining sloughs) during the Initial Stewardship Period was identified as an area of particular interest. The concern was that the salinity of the discharges might exceed the tolerances of resident aquatic species and, consequently, have an adverse impact on the aquatic communities in the receiving waters.

As described in this document, an evaluation was performed to determine if the elevated salinity of the circulated pond waters is expected to adversely impact aquatic life in the receiving waters. The results of this evaluation indicate that during the Initial Release Period, salinities in segments of S.F. Bay and its tributaries are predicted to be elevated, but significant impacts to aquatic life would be unlikely. The highest elevations are predicted for the sloughs and creeks into which pond water will be directly circulated (i.e., Alviso Slough, Gaudalupe Slough, Coyote Creek, and Alameda Flood Control Channel). However, even under worst-case discharge conditions (i.e., all ponds simultaneously commence discharge at maximum proposed salinities), the resulting salinities should still be within the tolerance range of most resident species. Under more realistic discharge conditions (i.e., only a subset of the ponds simultaneously commence discharge at lower salinities), salinity elevations in these tributaries would be considerably lower and potential risk to aquatic life would be minimal. In South S.F. Bay proper (south of the San Mateo Bridge), salinity elevations under worse-case discharge conditions are predicted to be only in the 1 to 2 ppt range, except for very localized areas near actual discharge points and slough mouths, where elevations may reach 4 ppt. Such small increases in salinity, which will last less than two months, are not expected to adversely impact resident aquatic species.

During the Continuous Circulation Period, salinity elevations in all segments of S.F. Bay and its tributaries are predicted to be sufficiently low so as not to present a risk to resident aquatic life. In S.F. Bay, salinity elevations are predicted to be quite localized and not to exceed 1 ppt at any time of the year. In the tributaries, salinity increases are predicted to vary seasonally, with very low values during the winter and somewhat higher values during the late summer and fall (i.e., highest pond salinities and lowest tributary flow). Even during the worst-case times of the year, salinities in the tributaries during the Continuous Circulation Period are not expected to pose a risk to resident aquatic life.

The evaluations upon which these conclusions are based are described in detail in the following sections of this document.

2. APPROACH

The concern about the potential for elevated salinity of the circulated pond water to adversely impact aquatic life inhabiting segments of the receiving waters was evaluated using a multi-step approach. First, the range of salinities for each of the discharges was predicted for both the initial release and continuous circulation periods. Second, predictions were made as to how the discharges would alter the salinity in segments of the receiving waters (i.e., both in sloughs and in the bay proper) during both Initial Release and Continuous Circulation periods. Third, based on available data, estimates were made as to the composition of the aquatic communities in the various waterbodies into which pond water would be circulated. Fourth, based on a review of the scientific literature, the sensitivity of resident aquatic organisms to changes in salinity was estimated. Fifth, the predicted salinity changes were compared with the estimated salinity tolerances of the resident species to predict what, if any, salinity-related impacts resident species might suffer from the proposed discharges.

Predictions of salinities in pond discharges and in receiving waterbodies were made using mathematical models which are described in a separate document. The simulation period for this modeling was April 1994 through October 1995. This period was selected because it included a relatively recent period where bay tidal and salinity profile information were available and to include a range of meteorological conditions. The 1994 period was considered suitable because it represents a relatively dry year, with above average salinity in the South Bay. Modeling initial release and summer continuous circulation under spring and summer 1994 conditions produces a conservative estimate of bay and slough salinities because, during this period, bay salinities were higher than average, intake salinities to the ponds would, consequently, be high, and flows in creeks to wash out pond discharges would be low. The 1995 period was used to model long-term Initial Stewardship Period operation during wet years with low average salinity in the bay and sloughs. Modeling continuous circulation under 1995 winter and spring conditions allows evaluation of potential increases in salinity during periods of low bay and slough salinity.

The locations of the planned discharge points from the Alviso and Baumberg Unit ponds during the Initial Stewardship Period are illustrated in Figure 1A.

3. ESTIMATION OF DISCHARGE SALINITIES

The salinity of each of the discharges is predicted to vary over the course of the Initial Stewardship Period. In all cases, the salinity will be the highest during the Initial Release Period, when the water which has been concentrated by evaporation is first pushed out of the ponds. There will be variation between discharge points, but, in general, the discharge of the high salinity waters will last for between 1 and 2 months, with the salinity of the discharge decreasing with time. After this Initial Release Period, water will be circulated through the ponds in a manner that will prevent discharge salinities from exceeding 44 ppt. Under most scenarios, the actual discharge salinities during this Continuous Circulation Period will vary over the course of the year, with lower salinities during the wet season (due to dilution by rainwater and low evaporation rates) and higher during the dry season (due to high evaporation rates). It is anticipated that for most of the year, during the Continuous Circulation Period, the salinity of the discharges will be considerably less than 44 ppt.

Estimates of the range of salinities of the discharges from the Alviso, Baumberg, and West Bay Unit Ponds during the Initial Release and Continuous Circulation Periods are summarized in Table 1. These estimates were made using mathematical modeling techniques which are described in a separate addendum to this application. It is anticipated that nine of these discharges (i.e., Alviso A2W, A3W, A7, A14, and A16 and Baumberg 2, 2C, 8A, and 11) will commence during the first year of the Initial Stewardship period and these discharges are further addressed in this evaluation. The West Bay Unit Ponds and the Alviso Island Ponds (A19, A20, and A21) will not commence discharge until later years and, therefore, are not addressed further in this evaluation. For each of the ten first-year discharges, up to four salinity ranges are presented:

- The first range represents the predicted salinity of the discharge during the Initial Release Period (approximately the first two months of discharge) assuming that the discharge commences on April 1 and is based upon the pond salinities actually observed in 2002. This range is designated Initial Release Period (2002 Conditions).

- The second range represents the predicted salinity of the discharge during the Initial Release Period assuming that the discharge commences on April 1 and is based on maximum pond salinities that were observed over the past five years or that could be expected during a very dry year. This range is designated Initial Release Period (Maximum Proposed Salinity).

- The third range represents the predicted salinity of the discharge during the Initial Release Period assuming that the discharge commences July 1 and is based on maximum predicted pond salinities observed over the past five years. This range is designated Phased Initial Release Period (Maximum Proposed Salinity). Only six of the ten discharges (Alviso A2W, A3W, and A7 and Baumberg 2, 8A and 11) are assigned this range because they are the only discharges that would commence during this period.

- The fourth range represents the predicted salinity of the discharge after the initial release has been completed. This range is designated the Continuous Circulation Period and will continue until the Initial Stewardship period comes to an end.

Figures 1-10 illustrate how the salinity of each of the ten discharges is predicted to vary over time during the Initial Stewardship Period. Each figure has up to three parts. The first two parts pertain to discharges that commence on April 1. In the first of these, predictions of discharge salinity are based on the assumption that, at the beginning of the Initial Release Period, the salinities of the contributing ponds are set at 2002 values (i.e., "Initial Release 2002 Conditions" followed by "Continuous Circulation"). In the second of these, predictions of discharge salinity are based on the assumption that, at the beginning of the Initial Release Period, the salinities of the contributing ponds are set at maximum proposed values (i.e., "Initial Release Maximum Proposed Salinity" followed by "Continuous Circulation"). The third part of the figure (actually in only 6 out of the 10 figures) pertains to discharges that commence on July 1 and the assumption is that, at the beginning of the Initial Release Period, the salinities of the contributing ponds are set at maximum proposed values (i.e., "Initial Phased Release Maximum Proposed Salinity" followed by "Continuous Circulation").

4. CHANGES IN SALINITY

The saline water circulated from the salt ponds during the Initial Stewardship Period will enter either directly into the South Bay or into one of several tributaries that eventually discharge into the South Bay. Segments of the South Bay and of each of these tributaries will experience increases in salinity as a result of these discharges. The magnitude of these increases will vary over the course of the initial stewardship period, but will be the greatest during initial release. In this section, the nature of these increases in salinity are discussed for each of two segments of San Francisco Bay proper (i.e., near the Alviso Unit and near the Baumberg Unit) and for each of four tributaries (Alameda Flood Control Channel, Coyote Creek, Alviso Slough, and Guadalupe Slough). For each receiving waterbody, changes in salinity are predicted during both the Initial Release and the Continuous Circulation Periods. For the Initial Release Period, in order to capture the full range of predicted changes in salinity, evaluations are made for two points in time – i.e., (1) the week when the highest salinities are being discharged and (2) at the end of the Initial Release Period when the lowest salinities are being discharged. Similarly, in order to capture the full range of outcomes for the Continuous Circulation Period, evaluations are made for four points in time – i.e., (1) at the end of September when pond salinities are predicted to be the highest and freshwater inflow the lowest, (2) during a winter storm event when pond salinities are predicted to be the lowest and freshwater inflow the highest, (3) during a winter dry period when pond salinities are predicted to be low and freshwater inflow is moderate, and (4) late spring dry period when pond salinities are relatively low and freshwater inflow is relatively low.

Predictions of changes in receiving water salinities during the Initial Release Period were made under three sets of discharge conditions. One set of conditions assumes that the five Alviso ponds (A2W, A3W, A7, A14, and A16) and the four Baumberg ponds (2, 2C, 8A, and 11) simultaneously commence discharge on April 1 and the salinity of the discharges are estimated based on salinities actually observed in 2002, when the pond system was being operated to simulate expected future discharge conditions. The second set of conditions assumes that the five Alviso ponds and the five Baumberg ponds simultaneously commence discharge on April 1 and the salinity of each of the discharges is at its proposed maximum level. The third set of conditions assumes that a subset of the Alviso ponds (A2W, A3W, and A7) and Baumberg ponds (2, 8A, and 11) simultaneously commence discharge on July 1 and the salinity of each of these discharges is at its proposed maximum level and is termed Phased Initial Release.

In the following subsections of this chapter, predicted changes in salinity are described for each of six receiving water segments (i.e., S.F. Bay near Alviso, S.F. Bay near Baumberg, Alameda Flood Control Channel, Coyote Creek, Alviso Slough, and Guadalupe Slough). In each of these subsections, the following three types of figures are presented to illustrate how salinity is predicted to change in a receiving water segment over both space and time:

1. The first type of figure is a set of three maps. Two of these maps illustrate predicted salinity contours on a specified day under existing conditions (i.e., no pond discharge) and under discharge conditions. The third map is a comparison of the first two maps and illustrates salinity differences between the existing and discharge conditions. The salinity contours are both depth-averaged and daily-averaged.

2. The second type of figure is a set of two longitudinal transects of the slough or creek in question, from its mouth to a point sufficiently far upstream to be out of the influence of the discharges. This figure illustrates salinity profiles along the length of the waterbody under existing and discharge conditions , at a single instant in time.

3. The third type of figure is a time-series graph which illustrates how salinity at a specified geographic location in the waterbody in question changes as a function of time under existing and discharge conditions. These graphs each cover a single month and are based on depth-average salinities at the center of the main channel in the waterbody.

4.1 South Bay Near Alviso

This segment of the receiving waters includes San Francisco Bay proper south of the Dumbarton Bridge. The salinity of this segment will be affected primarily by the circulation from five discharge points – i.e., A2W (direct discharge to bay), A3W (discharge via Guadalupe Slough), A7 (discharge via Alviso Slough), A14 (discharge via Coyote Creek), and A16 (discharge via Artesian Slough).

Initial Release Period – Commence April 1 at 2002 Salinity Values – Under this set of conditions, the predicted salinity profiles in this southernmost segment of S.F. Bay during the Initial Release Period are illustrated in Figures 11 and 12. The highest salinity elevations (depth-averaged and daily averaged) are predicted to occur during the fifth week of discharge and result in increases in small segments of the South Bay of 1 ppt (Figure 11). These small elevations in salinity will be confined to areas in the immediate vicinity of the A2W discharge point and at the mouth of Coyote Creek. After 8 weeks of discharge, these very small increases will have virtually disappeared (Figure 12). Time series plots are presented for a mid-channel point under the Dumbarton Bridge, which is the northern boundary of the South Bay. A review of these plots (Figures 13 and 14) indicates that the initial release of water from the five Alviso and five Baumberg Ponds does not alter the depth-averaged salinity experienced at that point in the bay during the first two months of discharge.

Initial Release Period – Commence April 1 at Maximum Proposed Salinity - Under this set of conditions, the predicted salinity profiles in this southernmost segment of S.F. Bay during the Initial Release Period are illustrated in Figures 17 and 18. The highest salinity elevations (depth-averaged and daily averaged) are predicted to occur during the sixth week of discharge and result in increases in all of the South Bay in the range of 1-3 ppt (Figure 17). The greatest elevations in salinity will occur in the southern third of the South Bay, with some small pockets of salinity increase as high as 4 ppt in those areas in the immediate vicinity of the A2W discharge point and at the mouth of Coyote Creek. After 8 weeks of discharge, salinity increases will still be observed throughout the entire South Bay, but are reduced to 1-2 ppt, with some small pockets of salinity increase as high as 3 ppt in those areas in the immediate vicinity of the A2W discharge point and at the mouth of Coyote Creek (Figure 18). Time series plots are presented for a mid-channel point under the Dumbarton Bridge, which is the northern boundary of the South Bay. A review of these plots (Figures 19 and 20) indicates that the initial release of water from the five Alviso and five Baumberg Ponds increases both the minimum and maximum depth-averaged salinities experienced at that point in the bay during the first two months of discharge by between 1 and 2 ppt.

Phased Initial Release Period – Commence July 1 at Maximum Proposed Salinity - Under this set of conditions, the predicted salinity profiles in this southernmost segment of S.F. Bay during the Phased Initial Release Period are illustrated in Figures 23-25. The highest salinity elevations (depth-averaged and daily averaged) in S.F. Bay south of the Dumbarton Bridge are predicted to occur during the sixth week of discharge and result in increases in the southern end of the South Bay 1 ppt (Figure 24). Some small pockets of salinity increase as high as 2 ppt will occur in those areas in the immediate vicinity of the A2W discharge point. After 8 weeks of discharge, the very small salinity increases will remain essentially unchanged in location and magnitude (Figure 25). Time series plots are presented for a mid-channel point under the Dumbarton Bridge, which is the northern boundary of the South Bay. A review of these plots (Figures 26 and 27) indicates that the initial release of water from the five Alviso and five Baumberg Ponds increases both the minimum and maximum depth-averaged salinities experienced at that point in the bay during the first two months of discharge by approximately 1 ppt.

Continuous Circulation – After the Initial Release Period has been completed, circulation through the ponds will be continued in order to maintain pond salinities at target values. The predicted range of salinity in the contributing discharges during this period are summarized in Table 1 and the temporal salinity patterns are illustrated in Figures 1-5. It should be noted that, regardless of initial pond salinities, once the Initial Release Period has been completed, the salinity of each discharge during the Continuous Circulation Period is predicted to follow the patterns illustrated in Figures 1-5 (i.e., for each discharge, all initial salinity conditions converge into the same long-term salinity pattern). As discussed earlier in this section, the resulting salinities in south S.F. Bay during the Continuous Circulation Period were examined under four sets of conditions and the results (depth-averaged and daily-averaged) are illustrated in Figures 30-33. In late September, when pond discharge salinities are predicted to be relatively high and freshwater inflow from other sources is expected to be low, minor increases in bay salinity of 1 ppt are predicted for very localized areas near the mouth of Coyote Creek and near the A2W outfall (Figure 30). In the winter, when pond discharge salinities are predicted to be relatively low, no significant increases in bay salinity are predicted during either dry periods or storm events (Figures 31 and 32). In the late spring, when both pond salinities and freshwater inflows are predicted to be relatively low, no significant increases in bay salinity are predicted (Figure 33).

4.2 South Bay Near Baumberg

This segment of the receiving waters includes San Francisco Bay proper between the Dumbarton Bridge and the San Mateo Bridge. The salinity of this segment will be affected primarily by the circulation from five discharge points – i.e., Pond 2 (direct discharge to bay), Pond 11 (direct discharge to bay), Pond 2C (discharge via Alameda Flood Control Channel, Pond 8A (discharge via Old Alameda Creek, and Pond 6A (discharge via Old Alameda Creek).

Initial Release Period – Commence April 1 at 2002 Salinity Values – Under this set of conditions, the predicted salinity profiles in S.F. Bay near the Baumberg Unit during the Initial Release Period are illustrated in Figures 11 and 12. The highest salinity elevations (depth-averaged and daily-averaged) in this section of the bay are predicted to occur during the fifth week of discharge and will result in increases in a segments of the bay of 1 ppt (Figure 11). This small elevation in salinity will be confined to an area along the length of the Baumberg Unit ponds, extending from Old Alameda Creek to south of the Alameda Flood Control Channel. After 8 weeks of discharge, these very small increases will have virtually disappeared (Figure 12). Time series plots are presented for two locations in S.F. Bay - a mid-channel point under the Dumbarton Bridge (which is the southern boundary of this segment of the bay) and a mid-channel point under the San Mateo Bridge (which is the northern boundary). A review of the plots (Figures 13-16) indicates that the initial release of water from the five Alviso and five Baumberg Ponds does not alter the depth-averaged salinity experienced at that either location in the bay during the first two months of discharge.

Initial Release Period – Commence April 1 at Maximum Proposed Salinity - Under this set of conditions, the predicted salinity profiles in the S.F. Bay near the Baumberg Unit during the Initial Release Period are illustrated in Figures 17 and 18. The highest salinity elevations (depth-averaged and daily-averaged) in this section of the bay are predicted to occur during the sixth week of discharge and will result in increases in all of the South Bay in the range of 1-4 ppt (Figure 17). Elevated salinity is predicted for a large portion of the bay, extending from the Dumbarton Bridge in the south to Old Alameda Creek in the north and all the way across the bay to the west. The highest of these salinity increases will be confined to an area along the length of the Baumberg Unit ponds, extending from Old Alameda Creek to the Dumbarton Bridge. After 8 weeks of discharge, salinity increases will still be observed in the same geographic area, but will have been diminished to 1-2 ppt (Figure 18). Time series plots are presented for two locations in S.F. Bay - a mid-channel point under the Dumbarton Bridge (which is the southern boundary of this segment of the bay) and a mid-channel point under the San Mateo Bridge (which is the northern boundary). A review of the plots indicates that, during the first two months of the initial release, the depth-averaged salinity at the Dumbarton Bridge is increased by between 1 and 2 ppt (Figures 19 and 20) whereas the depth-averaged salinity at the San Mateo Bridge remains unchanged (Figures 21 and 22).

Phased Initial Release Period – Commence July 1 at Maximum Proposed Salinity - Under this set of conditions, the predicted salinity profiles in the S.F. Bay near the Baumberg Unit during the Phase Initial Release Period are illustrated in Figures 23-25. The highest salinity elevations (depth-averaged and daily-averaged) in this section of the bay are predicted to occur during the second week of discharge and will result in increases of 1-3 ppt in a section of the bay along the length of the Baumberg Unit ponds, being centered at the mouth of the Alameda Flood Control Channel (Figure 23). After 8 weeks of discharge, the salinity increases will have virtually disappeared in this section of the bay (Figure 25). Time series plots are presented for two locations in S.F. Bay - a mid-channel point under the Dumbarton Bridge (which is the southern boundary of this segment of the bay) and a mid-channel point under the San Mateo Bridge (which is the northern boundary). A review of the plots indicates that, during the first two months of the initial release, the depth-averaged salinity at the Dumbarton Bridge is increased by approximately 1 ppt (Figures 26 and 27) whereas the depth-averaged salinity at the San Mateo Bridge remains unchanged (Figures 28 and 29).

Continuous Circulation– After the Initial Release Period has been completed, circulation through the ponds will be continued in order to maintain pond salinities at target values. The predicted range of salinity in the contributing discharges during this period are summarized in Table 1 and the temporal salinity patterns are illustrated in Figures 6-10. It should be noted that, regardless of initial pond salinities, once the Initial Release Period has been completed, the salinity of each discharge during the Continuous Circulation Period is predicted to follow the patterns illustrated in Figures 6-10 (i.e., for each discharge, all initial salinity conditions converge into the same long-term salinity pattern). As discussed earlier in this section, the resulting salinities in S.F. Bay near Baumberg during the Continuous Circulation Period were examined under four sets of conditions and the results are illustrated in Figures 30-33. No salinity increases (depth-averaged and daily-averaged) are predicted in S.F. Bay between the Dumbarton and San Mateo Bridges, under any of those conditions during the Continuous Circulation Period.

4.3 Alameda Flood Control Channel

Changes in the salinity of the Alameda Flood Control Channel were evaluated for a reach of the channel starting at its mouth and extending 8 kilometers upstream (Figure 34). The salinity of this 8 km reach will be affected primarily by the circulation from Pond 2C.

Initial Release Period – Commence April 1 at 2002 Salinity Values – Under this set of conditions, the predicted salinity profiles in the AFCC during the Initial Release Period are illustrated in Figures 35-42. The highest salinity elevations (depth-averaged and daily-averaged) in the channel are predicted to occur during the fifth week of discharge and will result in increases of 2-6 ppt along the channel from its mouth to a distance 8 km upstream (Figures 35 and 36). The greatest salinity elevation in the channel is predicted to occur in the vicinity of the Pond 2C discharge. It should be noted that (as illustrated in Figure 36) the major effect of the circulation of pond water is not to change the salinity gradient, but to shift it upstream and somewhat compress it. After 8 weeks of discharge, these increases will be reduced to 2 ppt or less (Figures 37 and 38). Time series plots are presented for two locations along the channel – i.e., at 1 and 5 km from the mouth. A review of these plots (Figures 39-42) indicates that the initial release of water from Pond 2C increases the minimum depth-averaged salinity experienced in the creek, but not the maximum. At a distance of 1 km upstream, the maximum depth-averaged salinity during the first two months of the Initial Release Period is predicted to be between 23 and 28 ppt (Figures 39 and 40). At a distance of 5 km upstream, the maximum depth-averaged salinity during the first two months of the Initial Release Period is predicted to be between 0 and 25 ppt (Figures 41 and 42).

Initial Release Period – Commence April 1 at Maximum Proposed Salinity - Under this set of conditions, the predicted salinity profiles in the AFCC during the Initial Release Period are illustrated in Figures 43-50. The highest salinity elevations (depth-averaged and daily-averaged) in the channel are predicted to occur during the fifth week of discharge and will result in increases of 6-14 ppt along the channel from its mouth to a distance 8 km upstream (Figures 43 and 44). The greatest salinity elevation in the channel is predicted to occur in the vicinity of the Pond 2C discharge. After 8 weeks of discharge, these increases will be reduced to 6 ppt or less (Figures 45 and 46). Time series plots are presented for two locations along the channel – i.e., at 1 and 5 km from the mouth. A review of these plots (Figures 47-50) indicates that the initial release of water from Pond 2C increases both the minimum and the maximum depth-averaged salinity experienced in the channel. At a distance of 1 km upstream (i.e., near the mouth of the AFCC), the maximum depth-averaged salinity during the first five weeks of the Initial Release Period is predicted to be between 28 and 37 ppt and during the next three weeks to between 28 and 30 ppt (Figures 47 and 48). At a distance of 5 km upstream, the maximum depth-averaged salinity during the two month Initial Release Period is predicted to be between 0 and 33 ppt (Figures 49 and 50).

Phased Initial Release Period – Commence July 1 at Maximum Proposed Salinity – It is not envisioned that the Initial Release of Pond 2C will commence in July and, therefore, an evaluation was not performed for this set of conditions in the AFCC.

Continuous Circulation– After the Initial Release Period has been completed, circulation through Pond 2C will be continued in order to maintain the contributing ponds at their target salinity values. The predicted range of salinity in the Pond 2C during this period is summarized in Table 1 and the temporal salinity pattern is illustrated in Figure 7. It should be noted that, regardless of initial salinity of Pond 2C, once the Initial

Release Period has been completed, the salinity of the discharge during the Continuous Circulation Period is predicted to follow the pattern illustrated in Figure 7 (i.e., for the Pond 2C discharge, all initial salinity conditions converge into the same long-term salinity pattern). As discussed earlier in this section, the resulting salinity in the AFCC during the Continuous Circulation period was examined under four sets of conditions and the results are illustrated in Figures 51-55. These figures indicate that during the fall and spring, salinity increases (depth-averaged and daily-averaged) in the range of 1 to 4 ppt are predicted to occur along the length of the channel. During the winter no salinity increases are predicted.

4.4 Coyote Creek & Artesian Slough

Changes in the salinity of Coyote Creek were evaluated for a reach of the creek starting at its mouth and extending approximately 7.5 kilometers upstream to the mouth of Artesian Slough. The evaluation continued into Artesian Slough for a distance of approximately 3.5 kilometers upstream to its source at the San Jose/Santa Clara Wastewater Treatment Plant (Figure 56). The salinity of this 11 km reach will be affected primarily by the circulation from Ponds A14 and A16 and from the contribution of water from Alviso and Guadalupe Sloughs which receive circulation from Ponds A7 and A3W, respectively.

Initial Release Period – Commence April 1 at 2002 Salinity Values – Under this set of conditions, the predicted salinity profiles in Coyote Creek during the Initial Release Period are illustrated in Figures 57-68. The highest salinity elevations (depth-averaged and daily-averaged) in the creek are predicted to occur during the first week of discharge and will result in increases of 1-5 ppt along Coyote Creek from its mouth to a distance 8 km upstream and along the 3 km length of Artesian Slough (Figures 57 and 58). The greatest salinity elevation in the channel is predicted to occur in the vicinity of the Ponds A14 and A16 discharges. After 8 weeks of discharge, these increases will be reduced to 2 ppt or less (Figures 59 and 60). Time series plots are presented for four locations along the creek – i.e., at 1, 5, 9, and 11 km from the mouth. A review of these plots (Figures 61-68) indicates that the initial release of water from Ponds A14 and A16 increases the minimum depth-averaged salinity experienced in the creek to a greater extent than the maximum. At a distance of 1 km upstream, the maximum depth-averaged salinity during the first two months of the Initial Release Period is predicted to be approximately 25 ppt (Figures 61 and 62). At a distance of 5 km upstream, the maximum depth-averaged salinity during the first two months of the Initial Release Period is predicted to be between 15 and 25 ppt (Figures 63 and 64). At a distance of 9 km upstream (i.e., in the downstream portion of Artesian Slough), the maximum depth-averaged salinity during the first two months of the Initial Release Period is predicted to be between 3 and 15 ppt (Figures 65 and 66). At a distance of 11 km upstream (i.e., in the upstream portion of Artesian Slough), the maximum depth-averaged salinity during the first two months of the Initial Release Period is predicted to be between 0 and 5 ppt (Figures 67 and 68).

Initial Release Period – Commence April 1 at Maximum Proposed Salinity - Under this set of conditions, the predicted salinity profiles in Coyote Creek during the Initial Release Period are illustrated in Figures 69-80. The highest salinity elevations (depth-averaged and daily-averaged) in the creek are predicted to occur during the first week of discharge and will result in increases of 12-14 ppt along Coyote Creek from its mouth to a distance 8 km upstream and along the 3 km length of Artesian Slough (Figures 69 and 70). The greatest salinity elevation in the channel is predicted to occur in the vicinity of the Ponds A14 and A16 discharges. After 8 weeks of discharge, these increases will be reduced to 6 ppt or less (Figures 71 and 72). Time series plots are presented for four locations along the creek – i.e., at 1, 5, 9, and 11 km from the mouth. A review of these plots (Figures 73-80) indicates that the initial release of water from Ponds A14 and A16 increases both the minimum and the maximum depth-averaged salinity experienced in the creek, with the minimum under discharge conditions generally being equal to or greater than the maximum under existing conditions. At a distance of 1 km upstream, the maximum depth-averaged salinity during the first two months of the Initial Release Period is predicted to be between 25 and 27 ppt (Figures 73 and 74). At a distance of 5 km upstream, the maximum depth-averaged salinity during the Initial Release Period is predicted to be between 27 and 32 ppt in the first month (Figure 75) and 20-27 in the second month (Figure 76). At a distance of 9 km upstream (i.e., in the downstream portion of Artesian Slough), the maximum depth-averaged salinity during the Initial Release Period is predicted to be between 8 and 23 ppt in the first month (Figure 77) and 5-16 in the second month (Figure 78). At a distance of 11 km upstream (i.e., in the upstream portion of Artesian Slough), the maximum depth-averaged salinity during the Initial Release Period is predicted to be between 0 and 8 ppt in the first month (Figure 79) and at 0 ppt in the second month (Figure 80).

Phased Initial Release Period – Commence July 1 at Maximum Proposed Salinity – It is not envisioned that the Initial Release of Ponds A14 and A16 will commence in July. However, Ponds A7 and A3W (which discharge into Alviso Slough and Guadalupe Slough, respectively) may commence in July. Since these sloughs flow into Coyote Creek, they may have an impact on the salinity of Coyote Creek and, therefore, an evaluation was performed for this set of conditions in Coyote Creek. Under this set of conditions, the predicted salinity profiles in Coyote Creek during the Phased Initial Release Period are illustrated in Figures 81-92. The highest salinity elevations (depth-averaged and daily-averaged) in the creek are predicted to occur during the third week of discharge and will result in increases of 1-2 ppt along the creek from its mouth to a distance 8 km upstream (Figures 81 and 82). The greatest salinity elevation in the channel is predicted to occur at the mouths of Alviso Slough and Guadalupe Slough. After 8 weeks of discharge, the conditions will be fairly unchanged (Figures 83 and 84). Time series plots are presented for four locations along the creek – i.e., at 1, 5, 9, and 11 km from the mouth. A review of these plots (Figures 85-92) indicates that the initial release of water from Ponds A7 and A3W slightly increases both the minimum and the maximum depth-averaged salinity experienced in the creek. At a distance of 1 km upstream, the maximum depth-averaged salinity during the first two months of the Initial Release Period is predicted to be between 27 and 31 ppt (Figures 85 and 86). At a distance of 5 km upstream, the maximum depth-averaged salinity during the first two months of the Initial Release Period is predicted to be between 15 and 28 ppt (Figures 87 and 88). At a distance of 9 km upstream (i.e., in the downstream portion of Artesian Slough), the maximum depth-averaged salinity during the first two months of the Initial

Release Period is predicted to be between 2 and 12 ppt (Figures 89 and 90). At a distance of 11 km upstream (i.e., in the upstream portion of Artesian Slough), the maximum depth-averaged salinity during the first two months of the Initial Release Period is predicted to be 0 ppt (Figures 91 and 92).

Continuous Circulation– After the Initial Release Period has been completed, circulation through Ponds A14 and A16 will be continued in order to maintain the contributing ponds at their target salinity values. The predicted ranges of salinity in the Ponds A14 and A16 during this period are summarized in Table 1 and the temporal salinity patterns are illustrated in Figures 4 and 5, respectively. It should be noted that, regardless of initial salinity of Ponds A14 and A16, once the Initial Release Period has been completed, the salinity of the discharge during the Continuous Circulation Period is predicted to follow the patterns illustrated in Figures 4 and 5 (i.e., for each of the two discharges, all initial salinity conditions converge into the same long-term salinity pattern). As discussed earlier in this section, the resulting salinity in Coyote Creek during the Continuous Circulation Period was examined under four sets of conditions and the results are illustrated in Figures 93-97. These figures indicate that during the fall and spring, salinity increases (depth-averaged and daily-averaged) in the range of 1 to 3 ppt are predicted to occur along the length of the creek. During the winter no salinity increases are predicted.

4.5 Alviso Slough

Changes in the salinity of Alviso Slough were evaluated for a reach of the slough starting at its mouth and extending 10 kilometers upstream (Figure 98). The salinity of this 10 km reach will be affected primarily by the circulation from Pond A7.

Initial Release Period – Commence April 1 at 2002 Salinity Values – Under this set of conditions, the predicted salinity profiles in Alviso Slough during the Initial Release Period are illustrated in Figures 99-106. The highest salinity elevations (depth-averaged and daily-averaged) in the slough are predicted to occur during the second week of discharge and will result in increases of 2-8 ppt along the slough from its mouth to a distance 8.5 km upstream (Figures 99 and 100). The greatest salinity elevation in the slough is predicted to occur in the vicinity of the Pond A7 discharge. After 8 weeks of discharge, these increases will be reduced to 4 ppt or less (Figures 101 and 102). Time series plots are presented for two locations along the slough – i.e., at 1 and 5 km from the mouth. A review of these plots (Figures 103-106) indicates that the initial release of water from Pond A7 produces variable patterns of depth-averaged salinity increase depending upon the distance upstream in the slough. At a distance of 1 km upstream, the discharge increases the minimum depth-averaged salinity experienced in the slough, but not the maximum. The maximum depth-averaged salinity at this 1 km station during the first two months of the Initial Release Period is predicted to be between 20 and 25 ppt (Figures 103 and 104). At a distance of 5 km upstream, the discharge increases both the maximum and the minimum depth-averaged salinity experienced in the slough. The maximum depth-averaged salinity at this 5 km station during the first two months of the Initial Release Period is predicted to be between 1 and 22 ppt (Figures 105 and 106).

It should be noted that, as illustrated in Figures 104 and 106, on May 7-9, there is a dramatic decrease in depth-averaged salinity at both the 1-km and 5-km stations under both existing and ISP conditions. This arises due to a rain event which increases freshwater flow into the slough and, consequently, flushes out saline water from the bay and the ponds.

Initial Release Period – Commence April 1 at Maximum Proposed Salinity - Under this set of conditions, the predicted salinity profiles in Alviso Slough during the Initial Release Period are illustrated in Figures 107-114. The highest salinity elevations in the slough are predicted occur during the second week of discharge and will result in increases of 4-20 ppt along the slough from its mouth to a distance 8.5 km upstream (Figures 107 and 108). The greatest salinity elevation (depth-averaged and daily-averaged) in the slough is predicted to occur in the vicinity of the Pond A7 discharge. After 8 weeks of discharge, these increases will be reduced to 6 ppt or less (Figures 109 and 110). Time series plots are presented for two locations along the slough – i.e., at 1 and 5 km from the mouth. A review of these plots (Figures 111-114) indicates that the initial release of water from Pond A7 increases both the minimum and the maximum depth-averaged salinity experienced in the creek, with the minimum under discharge conditions often being equal to or greater than the maximum under existing conditions. At a distance of 1 km upstream (i.e., near the mouth of Alviso Slough), the maximum depth-averaged salinity during the first three weeks of the Initial Release Period is predicted to be between 25 and 37 ppt and during the next five weeks to be between 24 and 26 ppt (Figures 111 and 112). At a distance of 5 km upstream, the maximum depth-averaged salinity during the first three weeks of the Initial Release Period is predicted to be between 12 and 38 ppt and during the next five weeks to be between 1 and 26 ppt (Figures 113 and 114).

Phased Initial Release Period – Commence July 1 at Maximum Proposed Salinity – It is envisioned that the Initial Release of Pond A7 may commence in July and, therefore, an evaluation was performed for this set of conditions in Alviso Slough. Under this set of conditions, the predicted salinity profiles in Alviso Slough during the Phased Initial Release Period are illustrated in Figures 115-122. The highest salinity elevations (depth-averaged and daily-averaged) in the slough are predicted to occur during the second week of discharge and will result in increases of 4-18 ppt along the slough from its mouth to a distance 8.5 km upstream (Figures 115 and 116). The greatest salinity elevation in the channel is predicted to occur in the vicinity of the Pond A7 discharge. After 8 weeks of discharge, these increases will be reduced to between 2 and 10 ppt (Figures 117 and 118). Time series plots are presented for two locations along the slough – i.e., at 1 and 5 km from the mouth. A review of these plots (Figures 119-122) indicates that the initial release of water from Pond A7 produces variable patterns of depth-averaged salinity increase depending upon the distance upstream in the slough. At a distance of 1 km upstream, the discharge increases both the minimum and maximum depth-averaged salinity in the slough, but the minimum to a greater extent. The maximum depth-averaged salinity at this 1 km station during the first month of the Initial Release Period is predicted to be between 22 and 33 ppt (Figure 119) and during the second month to be between 26 and 29 ppt (Figure 120). At a distance of 5 km upstream, the discharge increases both the maximum and the minimum depth-averaged salinity experienced in the slough, with the minimum under discharge conditions generally being greater than the maximum under existing conditions. The maximum depth-averaged salinity at this 5 km station during the first month of the Initial Release Period is predicted to be between 15 and 37 ppt (Figure 121) and during the second month to be between 26 and 34 ppt (Figure 122).

Continuous Circulation– After the Initial Release Period has been completed, circulation through Pond A7 will be continued in order to maintain the contributing ponds at their target salinity values. The predicted range of salinity in the Pond A7 during this period is summarized in Table 1 and the temporal salinity pattern is illustrated in Figure 3. It should be noted that, regardless of initial salinity of Pond A7, once the Initial Release Period has been completed, the salinity of the discharge during the Continuous Circulation Period is predicted to follow the pattern illustrated in Figure 3 (i.e., for the Pond A7 discharge, all initial salinity conditions converge into the same long-term salinity pattern). As discussed earlier in this section, the resulting salinity in Alviso Slough during the Continuous Circulation period was examined under four sets of conditions and the results are illustrated in Figures 123-127. These figures indicate that, during the fall, salinity (depth-averaged and daily-averaged) increases in the range of 2 to 8 ppt are predicted to occur along the length of the slough. During winter and spring, salinity increases of up to 2 ppt may occur.

4.6 Guadalupe Slough

Changes in the salinity of Guadalupe Slough were evaluated for a reach of the channel starting at its mouth and extending 8 kilometers upstream (Figure 128). The salinity of this segment will be affected primarily by the circulation from Pond A3W.

Initial Release Period – Commence April 1 at 2002 Salinity Values – Under this set of conditions, the predicted salinity profiles in Guadalupe Slough during the Initial Release Period are illustrated in Figures 129-136. The highest salinity elevations (depth-averaged and daily-averaged) in the slough are predicted to occur during the third week of discharge and will result in increases of 2-8 ppt along the slough from its mouth to a distance 9 km upstream (Figures 129 and 130). The greatest salinity elevation in the slough is predicted to occur in the vicinity of the Pond A3W discharge. After 8 weeks of discharge, these increases will be reduced to 6 ppt or less (Figures 131 and 132). Time series plots are presented for two locations along the slough – i.e., at 1 and 5 km from the mouth. A review of these plots (Figures 133-136) indicates that the initial release of water from Pond A3W produces variable patterns of depth-averaged salinity increase depending upon the distance upstream in the slough. At a distance of 1 km upstream, the discharge increases the minimum depth-averaged salinity experienced in the slough, but not the maximum. The maximum depth-averaged salinity at this 1 km station during the first two months of the Initial Release Period is predicted to be between 22 and 25 ppt (Figures 133 and 134). At a distance of 5 km upstream, the discharge increases both the maximum and the minimum depth-averaged salinity experienced in the slough. The maximum depth-averaged salinity at this 5 km station during the first two months of the Initial Release Period is predicted to be between 12 and 23 ppt (Figures 135 and 136).

Initial Release Period – Commence April 1 at Maximum Proposed Salinity - Under this set of conditions, the predicted salinity profiles in Guadalupe Slough during the Initial Release Period are illustrated in Figures 137-144. The highest salinity elevations (depth-averaged and daily-averaged) in the slough are predicted occur during the third week of discharge and will result in increases of 6-18 ppt along the slough from its mouth to a distance 9 km upstream (Figures 137 and 138). The greatest salinity elevation in the slough is predicted to occur in the vicinity of the Pond A3W discharge. After 8 weeks of discharge, these increases will be reduced to 4-16 ppt (Figures 139 and 140). Time series plots are presented for two locations along the slough – i.e., at 1 and 5 km from the mouth. A review of these plots (Figures 141-144) indicates that the initial release of water from Pond A3W increases both the minimum and the maximum depth-averaged salinity experienced in the creek, with the minimum under discharge conditions generally being greater than the maximum under existing conditions. At a distance of 1 km upstream (i.e., near the mouth of Guadalupe Slough), the maximum depth-averaged salinity during the first two months of the Initial Release Period is predicted to be between 25 and 28 ppt (Figures 141 and 142). At a distance of 5 km upstream, the maximum depth-averaged salinity during the first two months of the Initial Release Period is predicted to be between 10 and 32 ppt (Figures 143 and 144).

Phased Initial Release Period – Commence July 1 at Maximum Proposed Salinity – It is envisioned that the Initial Release of Pond A3W may commence in July and, therefore, an evaluation was performed for this set of conditions in Guadalupe Slough. Under this set of conditions, the predicted salinity profiles in Guadalupe Slough during the Phased Initial Release Period are illustrated in Figures 145-152. The highest salinity elevations (depth-averaged and daily-averaged) in the slough are predicted to occur during the second week of discharge and will result in increases of 4-20 ppt along the slough from its mouth to a distance 9 km upstream (Figures 145 and 146). The greatest salinity elevation in the channel is predicted to occur in the vicinity of the Pond A3W discharge. After 8 weeks of discharge, these increases will be reduced to between 4 and 14 ppt (Figures 147 and 148). Time series plots are presented for two locations along the slough – i.e., at 1 and 5 km from the mouth. A review of these plots (Figures 149-152) indicates that the initial release of water from Pond A3W increases both the minimum and the maximum depth-averaged salinity experienced in the creek, with the minimum under discharge conditions generally being greater than the maximum under existing conditions. At a distance of 1 km upstream, the maximum depth-averaged salinity during the first two months of the initial discharge period is predicted to be between 27 and 32 ppt (Figure 149 and 150). At a distance of 5 km upstream, the maximum depth-averaged salinity during the first month of the Initial Release Period is predicted to be between 16 and 37 ppt (Figure 151) and during the second month to be between 27 and 33 ppt (Figure 152).

Continuous Circulation– After the Initial Release Period has been completed, circulation through Pond A3W will be continued in order to maintain the contributing ponds at their target salinity values. The predicted range of salinity in the Pond A3W during this period is summarized in Table 1 and the temporal salinity pattern is illustrated in Figure 2. It should be noted that, regardless of initial salinity of Pond A3W, once the Initial Release Period has been completed, the salinity of the discharge during the Continuous Circulation Period is predicted to follow the pattern illustrated in Figure 2 (i.e., for the Pond A3W discharge, all initial salinity conditions converge into the same long-term salinity pattern). As discussed earlier in this section, the resulting salinity in Guadalupe Slough during the Continuous Circulation period was examined under four sets of conditions and the results are illustrated in Figures 153-157. These figures indicate that during the fall salinity increases (depth-averaged and daily-averaged) in the range of 2 to 8 ppt are predicted to occur along the length of the slough. During winter and spring, salinity increases of up to 4 ppt may occur.

5. AQUATIC COMMUNITY IN RECEIVING WATERS

As described in the preceding section of this report, the discharge of pond water during the Initial Stewardship Period will result in elevated salinity in portions of San Francisco Bay and its tributaries. The aquatic community that inhabits these locations has not been well characterized. However, available data provide some insight as to the likely community composition.

Fish Community in Sloughs – The composition of the fish communities in the five tributaries into which pond water will be circulated (i.e., Coyote Creek, Alviso Slough, Guadalupe Slough, Alameda Flood Control Channel, and Old Alameda Creek) can be estimated based on surveys performed in these and adjacent trbituaries. In a five-year study (1982-86) performed for the South Bay Dischargers Association (SBDA) (Kinnetics 1987), fish were collected and identified from two locations in Coyote Creek (SJ2 and SJ4) and one location in Guadalupe Slough (SJ6). The results of this study are summarized in Table 2 and indicate that these tributaries are inhabited by a number of estuarine fish species, including staghorn sculpin (*Leptocottus armatus*), northern anchovy (*Engraulis mordax*), starry flounder (*Platichthys stellatus*), shiner perch (*Cymatogaster aggregate*), yellowfin goby (*Acanthogobius flavimanus*), threadfin shad (*Dorosma petenense*), and longfin smelt (*Spirinchus thaleichthys*).

A more recent study performed for the City of Palo Alto (Cressey 1997) confirms that the fish species observed in the sloughs in the 1982-1986 are probably still present. In two tributaries to South Bay (i.e., San Francisquito Creek and the channel from the Palo Alto wastewater treatment plant to the bay), several fish species were collected including northern anchovy and topsmelt (*Atherinops affinis*), yellowfin goby, staghorn sculpin, and threespine stickleback (Table 3).

Fish Community in Bay Proper – The 1982-86 SBDA study (Kinnetics 1987) also provides data on the likely composition of the fish community in the waters of southern San Francisco Bay proper in the vicinity of the proposed pond discharges. Based on this study, it appears that the fish species in the bay proper will be quite similar to those found in the sloughs and will include northern anchovy, staghorn sculpin, shiner perch, longfin smelt, white croaker (*Genyonemus lineatus*), and striped bass (*Morone saxatilis*). The results of this study are summarized in Table 4, which includes sampling data from two locations in South San Francisco Bay – one location is designated SB4 and is just north of the Dumbarton Bridge and the other location is designated SB5 and is midway between the Dumbarton Bridge and the mouth of Coyote Creek.

Benthic Community in Sloughs – The composition of the benthic invertebrate communities inhabiting the five tributaries into which pond water will be circulated is not well characterized. No benthic data could be found for any of the five tributaries in question. However, the 1997 City of Palo Alto study (Cressey 1997) does provide data that are probably relevant to the five tributaries of concern. In the Cressey study, benthic communities in San Francisquito Creek and the discharge channel from the Palo Alto Wastewater Treatment Plant were sampled and the collected specimens identified. These two tributaries will not be receiving circulated pond water, but since they are geographically close to the tributaries in question and have similar morphologies, it is likely that they will also have similar benthic communities. The results of this study are summarized in Table 5 and indicate that benthic communities in the tributaries of concern are likely to be fairly simple, with the most abundant taxa being four species of annelids (*Neanthes succinea*, *Eteoni lighti*, *Tubificidae spp*, and *Heteromastus filiformis*), three species of arthropods (*Nippoleucon hinumensis*, *Corophium alienense*, and *Grandidierella japonica*) and two species of molluscs (*Macoma balthica* and *Potamocurbula ameurensis*). Interestingly, all of these species, except for *P. ameurensis,* were found at all stations in both tributaries, with salinities ranging from 1 to 27 ppt.

Benthic Community in Bay Proper – The composition of the benthic invertebrate community inhabiting the mudflats of South San Francisco Bay has been described by Nichols and Thompson (1985a & 1985b) and is summarized in Table 6. Based on data from 1974-83, it appears that the communities in the vicinity of the Alviso Unit and the Baumberg Unit are probably very similar, with three species being “the overwhelming numerical dominants” – these are *Gemma gemma* (a mollusc), *Ampelisca abdita* (an arthropod), and *Streblospio benedictii* (an annelid). In addition, according to Nichols and Thompson (1985b), “although much less abundant, the mollusks *Macoma balthica*, *Mya arenaria*, and *Illyanassa obsoleta* often represent the bulk of benthic invertebrate biomass”.

A more recent dataset was collected in 1994-96 as part of the Benthic Pilot Study of the San Francisco Estuary Regional Monitoring Program (RMP 1997). Based on these data, for estuarine muddy sediments, the most common and abundant species are *Potamocorbula amurensis*, *Ampelisca abdita, Nippoleucon hinumensis*, *Corophium heteroceratum*, *Corophium alienense*, *Grandiderella japonica*, *Balanus improvisus*, *Tubificidae sp.*, *Neanthes succinea*, and *Streblospio benedicti* . These data indicate that the species composition in the bay sediments in the vicinity of the Alviso and Baumberg Units has remained fairly consistent over time, with the exception of the marked increase in the abundance of a recent invading species *Potamocorbula amurensis*.

6. SENSITIVITY OF AQUATIC COMMUNITY TO ELEVATED SALINITY

The available literature indicates that the fish and benthic invertebrate species that inhabit areas that will be affected by the circulated pond water are likely to exhibit a range of sensitivities to elevated salinity. In addition, it appears that many of the more common species inhabiting the discharge areas are able to tolerate salinities considerably higher than seawater.

Data most relevant to determining the sensitivity of aquatic organisms to the proposed discharges comes from a survey by Lonzarich (1989) of fish and invertebrate species inhabiting six salt ponds in the Alviso Unit. These interconnected ponds each experienced a unique range of salinities and, consequently, the absence of species in certain higher-salinity ponds provides insight as to their upper salinity tolerances. As illustrated in Table 7, two species of fish (topsmelt and longjawed mudsuckers) were found to tolerate salinities from 22 to 83 ppt. Four other species (threespine stickleback, rainwater killifish, yellowfin goby, and pacific staghorn sculpin) were seasonally found in the higher salinity ponds and based on seasonal surveys were observed to tolerate the following salinities – threespine stickleback (65 ppt), yellowfin goby (50 ppt), rainwater killifish (80 ppt), and pacific staghorn sculpin (65 ppt). Comparison of these Lonzarick results with the fish species expected to be found in the waters into which the salt ponds will be circulated (Tables 2-4) indicates that several members of the fish community-at-risk can tolerate significantly elevated salinities. Topsmelt, yellowfin goby, and staghorn sculpin are commonly found in the discharge areas and were observed to tolerate salinities of 83, 50, and 65 ppt, respectively. In addition, threespine stickleback which is present, but less common, was observed to tolerate salinities as high as 65 ppt.

The Lonzarich data also provide valuable insights as to the sensitivities of benthic invertebrate species inhabiting the receiving waters. As illustrated in Table 8, Lonzarich found one annelid species (*Polydora ligni*) and four crustacean species (*Artemia salina, Balanus sp., Copepoda sp., and Corophium sp*.) which could tolerate salinities from 22 to 84 ppt. Several other species were not found in the highest salinity ponds, but were observed in ponds that seasonally reached 40 ppt. These included three mollusk species (*Gemma gemma*, *Ilyanassa obsoletus*, and *Tryonia imitator*), two annelid species (*Neries succinea* and *Tubificoides sp*.), and 6 crustacean species (*Anisogammarus confervicolus*, *Crangon spp*., *Hemigrapsus oregonensis*, *Ostracoda sp*., *Palaemon macrodactylus*, and *Sphaeroma quoyana*). Comparison of these Lonzarick results with the invertebrate species expected to be found in the waters into which the salt ponds will be circulated (Tables 5 and 6) indicates that several members of the benthic invertebrate community-at-risk can tolerate significantly elevated salinities. Two of the crustacean species common to the discharge areas (*Balanus sp*. and *Corophium sp*.) were observed to tolerate salinities as high as 84 ppt. In addition, one common annelid species (*Tubificoides sp*.) and two common mollusk species (*Gemma gemma* and *Ilyanassa obsoletus*) were observed to tolerate salinities as high as 40 ppt.

As mentioned previously, the results generated by Cressey (1997) also provide insight into the ability of benthic invertebrates resident in the bay and its tributaries to tolerate varied and elevated salinities. Eight of the nine most common species in San Francisquito Creek and the Palo Alto wastewater discharge channel have empirically observed wide salinity tolerances, being found in waters that ranged in salinity from 1 to 27 ppt. Most, if not all, of these species are expected to be residents of the waterbodies of interest.

The ability of estuarine species to tolerate elevated salinities is further supported in a comprehensive review on this and related subjects prepared by the U.S. Army of Engineer Waterways Experiment Station (Hopkins 1973). This book provides short abstracts of hundreds of articles dealing with the effects of salinity on marine and estuarine life. My review of these abstracts finds many references that report the ability of invertebrate, fish, and plant species to tolerate salinities greatly in excess of sea water. The more relevant of these tolerances are summarized in Table 9. In general, the referenced articles indicate that, for many species, tolerance of higher than normal salinities is more common than tolerance of lower than normal salinities.

7. PREDICTED IMPACTS

Throughout the Initial Stewardship Period, each of the various segments of the bay and its tributaries will experience a different exposure to saline pond water and, therefore, each of these segments is addressed separately in evaluating the potential for salinity-related impacts.

South Bay Proper - In the South Bay proper, elevated salinities resulting from the circulation of saline water from the Baumberg Unit ponds (2, 11, 2C, 8A, and 6A) and the Alviso Unit ponds (A2W, A3W, A7, A14, and A16) is unlikely to cause impacts to aquatic life. During the Initial Release Period, under worst-case conditions (i.e., all ponds simultaneously commence discharge at the highest proposed salinities), when salinity elevations will be the greatest, the increase in salinity is predicted to be less than 3 ppt, except in very localized areas near discharge points and at the mouths of sloughs where increases may be as high as 4 ppt. It should be noted that the salinity increases are predicted to be less under more realistic discharge conditions (i.e., initial salinities of the ponds are less than maximum and/or the discharges do not all commence simultaneously but are phased). Based on the available literature, these small increases in salinity are unlikely to adversely impact the estuarine species which are resident in the impacted segments of South San Francisco Bay. The resident organisms in the South Bay normally experience variations of several ppt on a daily basis and up to 10 ppt on a seasonal basis and many of the resident species are likely to have salinity tolerances greatly in excess of 32 ppt.

During the Continuous Circulation Period (i.e., after the initial flush of pond water during the Initial Release Period), elevated salinities in the South Bay proper are expected to be virtually non-existent. It is predicted that any increases will be 1 ppt or less and occur in very localized areas near discharge points and at the mouths of sloughs. Consequently, impacts to aquatic life in South Bay proper, resulting from elevated salinity, are not expected during the long-term Continuous Circulation Period.

Alameda Flood Control Channel – In the AFCC, elevated salinities resulting primarily from the circulation of saline water from Pond 2C are unlikely to cause significant impacts to aquatic life. During the Initial Release Period, under worst-case conditions (i.e., all ponds simultaneously commence discharge at the highest proposed salinities), when salinity elevations will be the greatest, the maximum increase in salinity is predicted to be 14 ppt in the vicinity of the Pond 2C discharge. Salinity increases will be lower in other segments of the slough and nowhere in the slough will salinities exceed approximately 37 ppt. At the end of the Initial Release Period (after approx. 8 weeks), a maximum salinity increase of 6 ppt will occur in the vicinity of the Pond 2C discharge point and lower salinity increases will occur in other segments of the slough. The maximum salinity at this time is predicted to be approximately 30 ppt. It should be noted that the salinity increases are predicted to be less under more realistic discharge conditions (i.e., initial salinity of the Pond 2C is less than maximum), with local maximum increases being in the 2-4 ppt range. Based on the available literature, these increases in salinity are unlikely to adversely impact the estuarine species which are resident in the impacted segments of the Alameda Flood Control Channel. The resident organisms in the AFCC normally experience variations of 15-20 ppt on a daily basis and up to 30 ppt on a seasonal basis and many of the resident species are likely to have salinity tolerances greatly in excess of 32 ppt.

During the Continuous Circulation Period (i.e., after the initial flush of water from Pond 2C during the Initial Release Period), elevated salinities in the AFCC are expected to be quite low. It is predicted that any increases will be in the range of 1-4 ppt and occur in channel segments near the Pond 2C discharge point. Consequently, impacts to aquatic life in the AFCC, resulting from elevated salinity, are not expected during the long-term Continuous Circulation Period.

Coyote Creek – In Coyote Creek, elevated salinities resulting from the circulation of saline water from Ponds A14 and A16 are unlikely to cause significant impacts to aquatic life. During the Initial Release Period, under worst-case conditions (i.e., all ponds simultaneously commence discharge at the highest proposed salinities), when salinity elevations will be the greatest, the maximum increase in salinity is predicted to be 14 ppt in the vicinity of the Pond A14 discharge. Salinity increases will be lower in other segments of the creek and nowhere in the creek will salinities exceed approximately 32 ppt. At the end of the Initial Release Period (after approx. 8 weeks), a maximum salinity increase of 6 ppt will occur in the vicinity of the Pond A14 discharge point and lower salinity increases will occur in other segments of the creek. The maximum salinity at this time is predicted to be approximately 26 ppt. It should be noted that the salinity increases are predicted to be less under more realistic discharge conditions (i.e., initial salinity of the Ponds A14 and A16 are less than maximum and/or the discharges do not all commence simultaneously but are phased), with local maximum increases being in the 1-5 ppt range. Based on the available literature, these increases in salinity are unlikely to adversely impact the estuarine species which are resident in the impacted segments of Coyote Creek. The resident organisms in Coyote Creek normally experience variations of 15-20 ppt on a daily basis and up to 30 ppt on a seasonal basis and many of the resident species are likely to have salinity tolerances greatly in excess of 32 ppt.

During the Continuous Circulation Period (i.e., after the initial flush of water from Ponds A14 and A16 during the Initial Release Period), elevated salinities in Coyote Creek are expected to be quite low. It is predicted that any increases will be 3 ppt or less and will occur in creek segments near the Pond A14 discharge point. Consequently, impacts to aquatic life in Coyote Creek, resulting from elevated salinity, are not expected during the long-term Continuous Circulation Period.

Alviso Slough – In Alviso Slough, elevated salinities resulting from the circulation of saline water from Pond A7 are unlikely to cause significant impacts to aquatic life. During the Initial Release Period, under worst-case conditions (i.e., all ponds simultaneously commence discharge at the highest proposed salinities), when salinity elevations will be the greatest, the maximum increase in salinity is predicted to be 20 ppt in the vicinity of the Pond A7 discharge. Salinity increases will be lower in other segments of the slough and nowhere in the slough will salinities exceed approximately 37 ppt. At the end of the Initial Release Period (after approx. 8 weeks), a maximum salinity increase of 8 ppt will occur in the vicinity of the Pond A7 discharge point and lower salinity increases will occur in other segments of the slough. The maximum salinity at this time is predicted to be approximately 26 ppt. It should be noted that the salinity increases are predicted to be less under more realistic discharge conditions (i.e., initial salinity of the Pond A7 is less than maximum and/or the discharges do not all commence simultaneously but are phased), with local maximum increases being in the 2-18 ppt range. Based on the available literature, these increases in salinity are unlikely to adversely impact the estuarine species which are resident in the impacted segments of Alviso Slough. The resident organisms in Alviso Slough normally experience variations of 15-20 ppt on a daily basis and up to 30 ppt on a seasonal basis and many of the resident species are likely to have salinity tolerances greatly in excess of 32 ppt.

During the Continuous Circulation Period (i.e., after the initial flush of water from Pond A7 during the Initial Release Period), elevated salinities in Alviso Slough are expected to be moderate. It is predicted that any increases will be 8 ppt or less and will occur in slough segments near the Pond A7 discharge point. Consequently, impacts to aquatic life in Alviso Slough, resulting from elevated salinity, are not expected during the long-term Continuous Circulation Period.

Guadalupe Slough - In Guadalupe Slough, elevated salinities resulting from the circulation of saline water from Pond A3W are unlikely to cause significant impacts to aquatic life. During the Initial Release Period, under worst-case conditions (i.e., all ponds simultaneously commence discharge at the highest proposed salinities), when salinity elevations will be the greatest, the maximum increase in salinity is predicted to be 18 ppt in the vicinity of the Pond A3W discharge. Salinity increases will be lower in other segments of the slough and nowhere in the slough will salinities exceed approximately 37 ppt. At the end of the Initial Release Period (after approx. 8 weeks), a maximum salinity increase of 14-16 ppt will occur in the vicinity of the Pond A3W discharge point and lower salinity increases will occur in other segments of the slough. The maximum salinity at this time is predicted to be approximately 30 ppt. It should be noted that the salinity increases are predicted to be less under more realistic discharge conditions (i.e., initial salinity of the Pond A3W is less than maximum), with local maximum increases being approximately 6 ppt. Based on the available literature, these increases in salinity are unlikely to adversely impact the estuarine species which are resident in the impacted segments of Guadalupe Slough. The resident organisms in Guadalupe Slough normally experience variations of 5-15 ppt on a daily basis and up to 30 ppt on a seasonal basis and many of the resident species are likely to have salinity tolerances greatly in excess of 32 ppt.

During the Continuous Circulation Period (i.e., after the initial flush of water from Pond A3W during the Initial Release Period), elevated salinities in Guadalupe Slough are expected to be moderate. It is predicted that any increases will be 8 ppt or less and will occur in slough segments near the Pond A3W discharge point. Consequently, impacts to aquatic life in Guadalupe Slough, resulting from elevated salinity, are not expected during the long-term Continuous Circulation Period.

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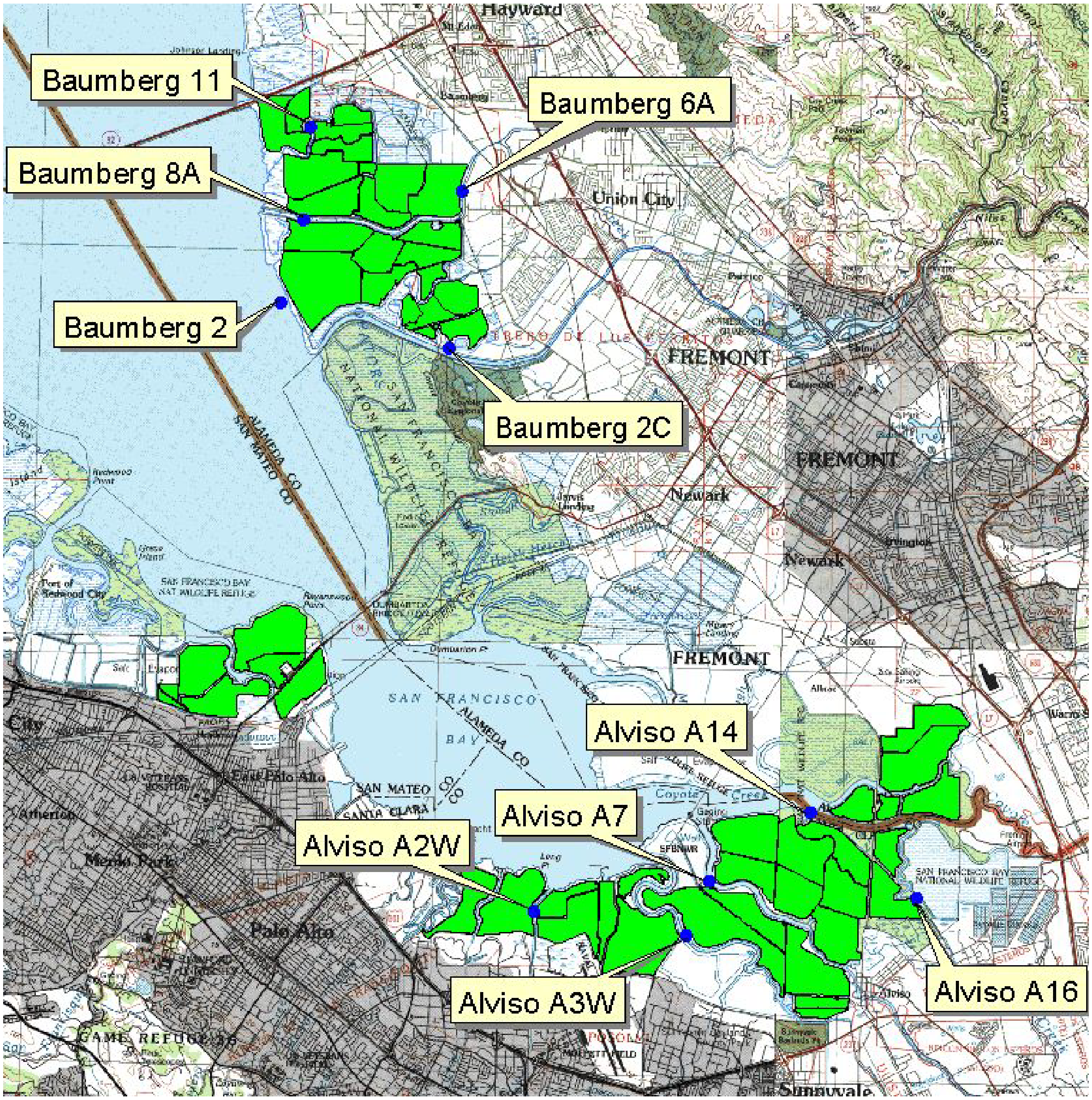


Figure 1A. Locations of planned discharges from the Alviso and Baumberg Unit Ponds during the Initial Stewardship Period.

Figure 1. Predicted Salinity Profile for the A2W Discharge

(based on 1994-95 weather conditions, tidal conditions, and bay salinity at intakes; proposed infrastructure and system operation)

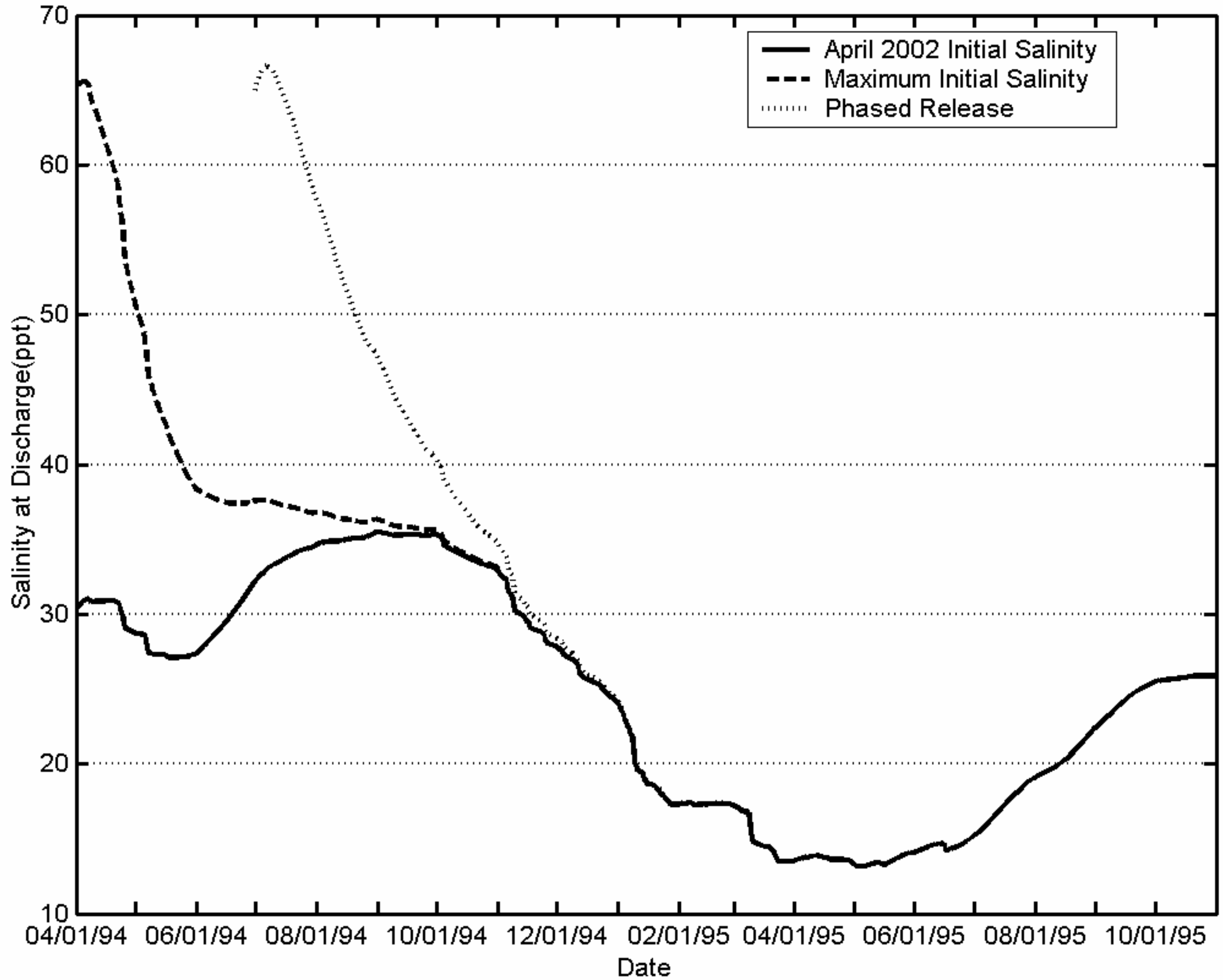


Figure 2. Predicted Salinity Profile for the A3W Discharge

(based on 1994-95 weather conditions, tidal conditions, and bay salinity at intakes; proposed infrastructure and system operation)

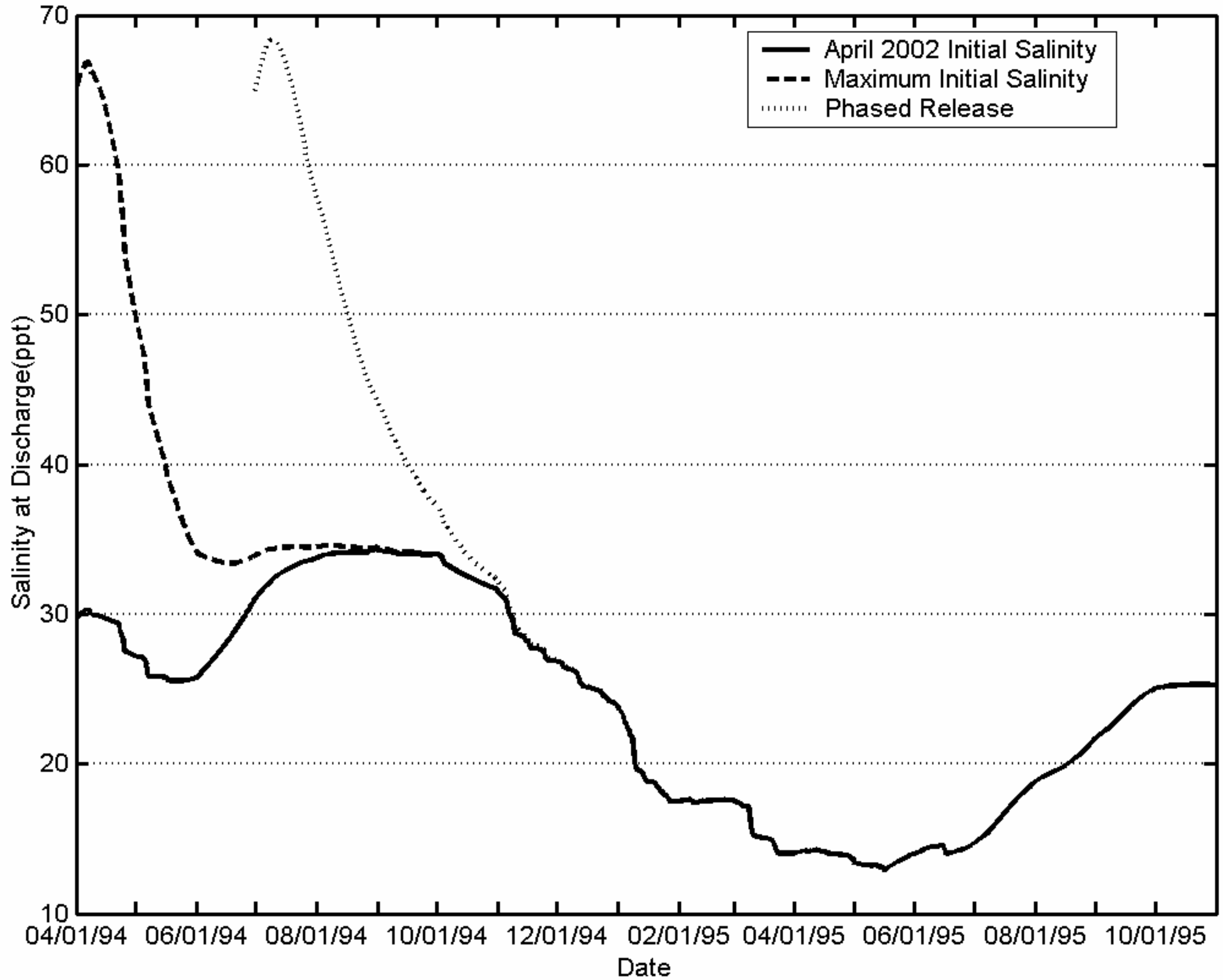


Figure 3. Predicted Salinity Profile for the A7 Discharge

(based on 1994-95 weather conditions, tidal conditions, and bay salinity at intakes; proposed infrastructure and system operation)

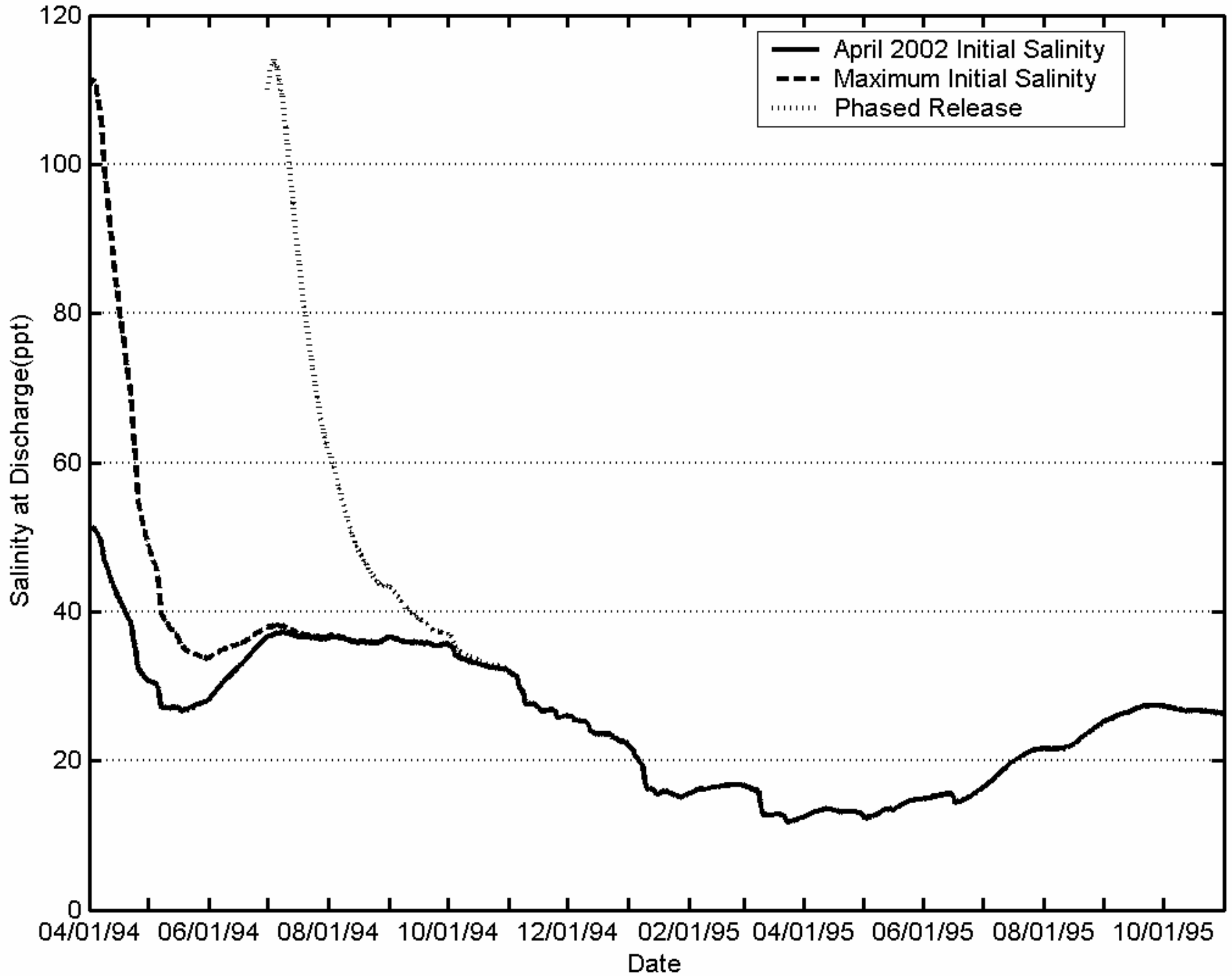


Figure 4. Predicted Salinity Profile for the A14 Discharge

(based on 1994-95 weather conditions, tidal conditions, and bay salinity at intakes; proposed infrastructure and system operation)

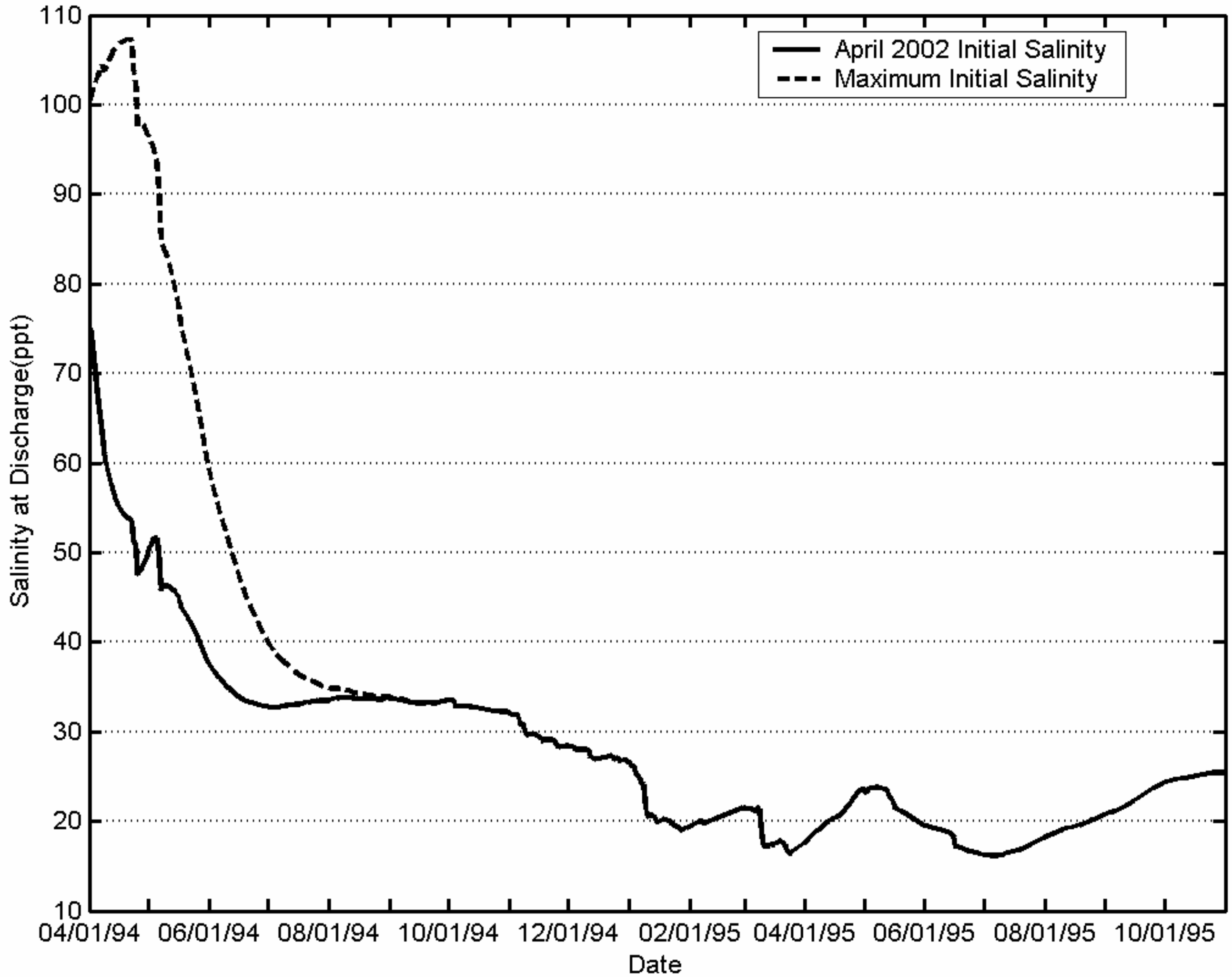


Figure 5. Predicted Salinity Profile for the A16 Discharge

(based on 1994-95 weather conditions, tidal conditions, and bay salinity at intakes; proposed infrastructure and system operation)

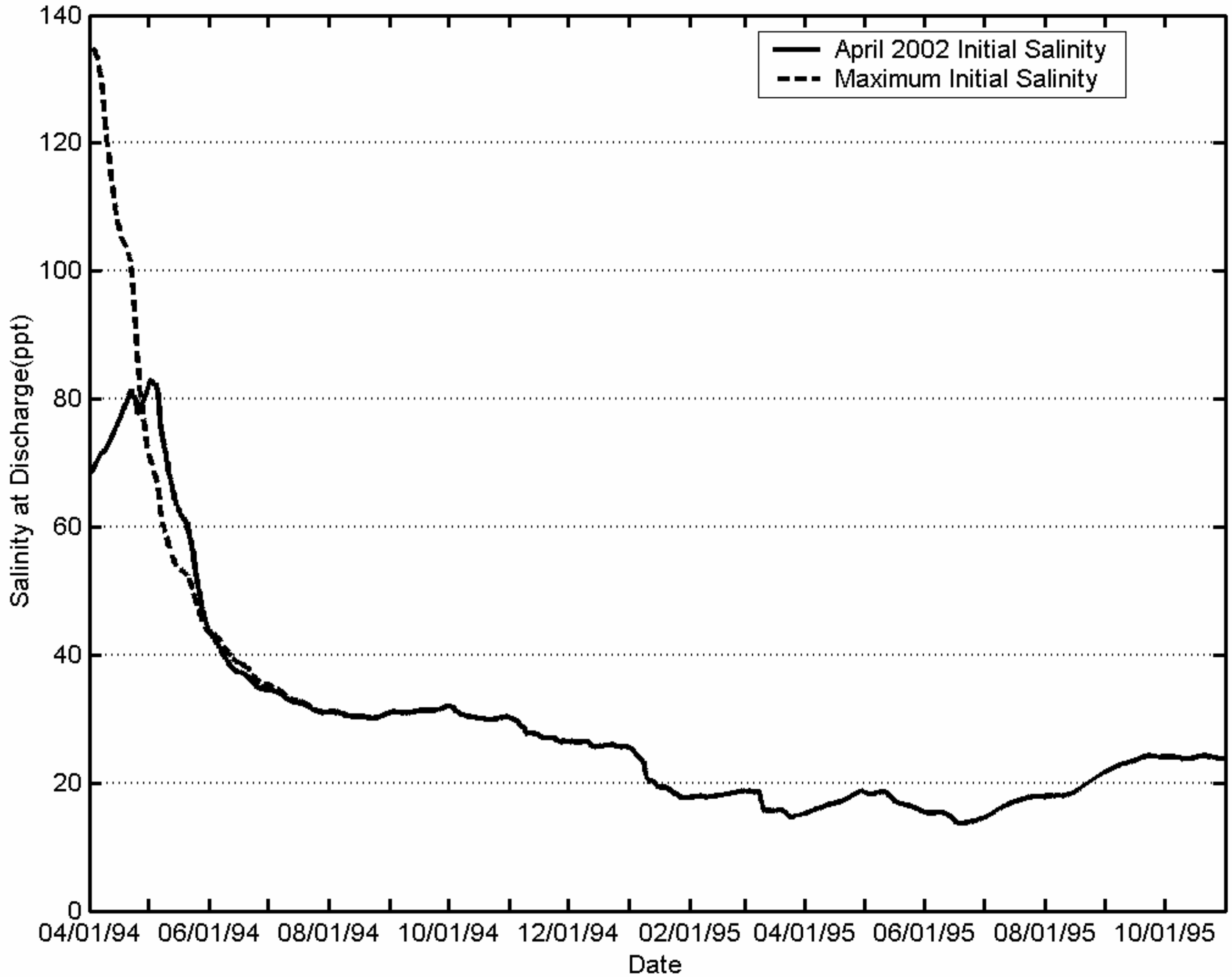


Figure 6. Predicted Salinity Profile for the Baumberg 2 Discharge

(based on 1994-95 weather conditions, tidal conditions, and bay salinity at intakes;
proposed infrastructure and system operation)

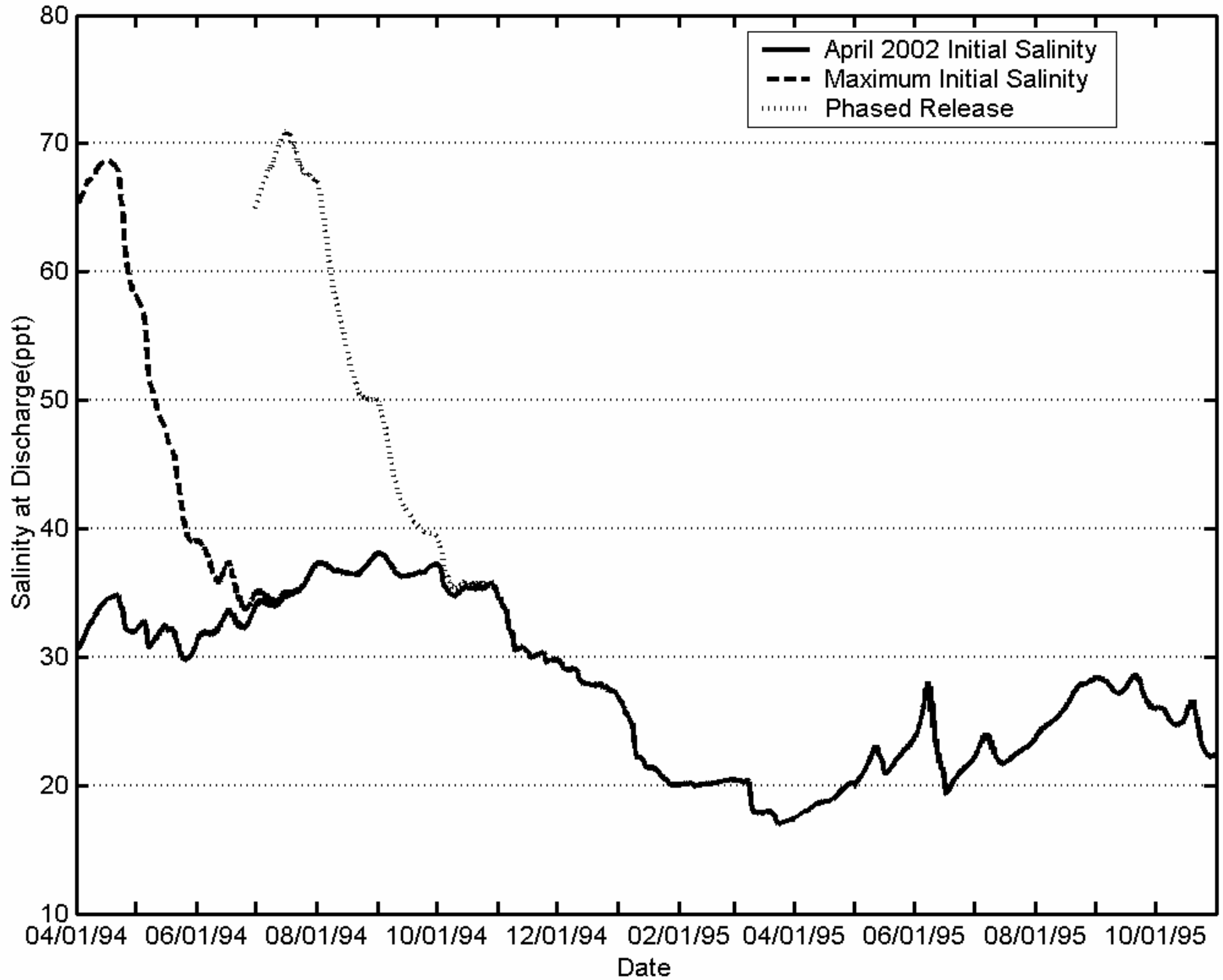


Figure 7. Predicted Salinity Profile for the Baumberg 2C Discharge

(based on 1994-95 weather conditions, tidal conditions, and bay salinity at intakes; proposed infrastructure and system operation)

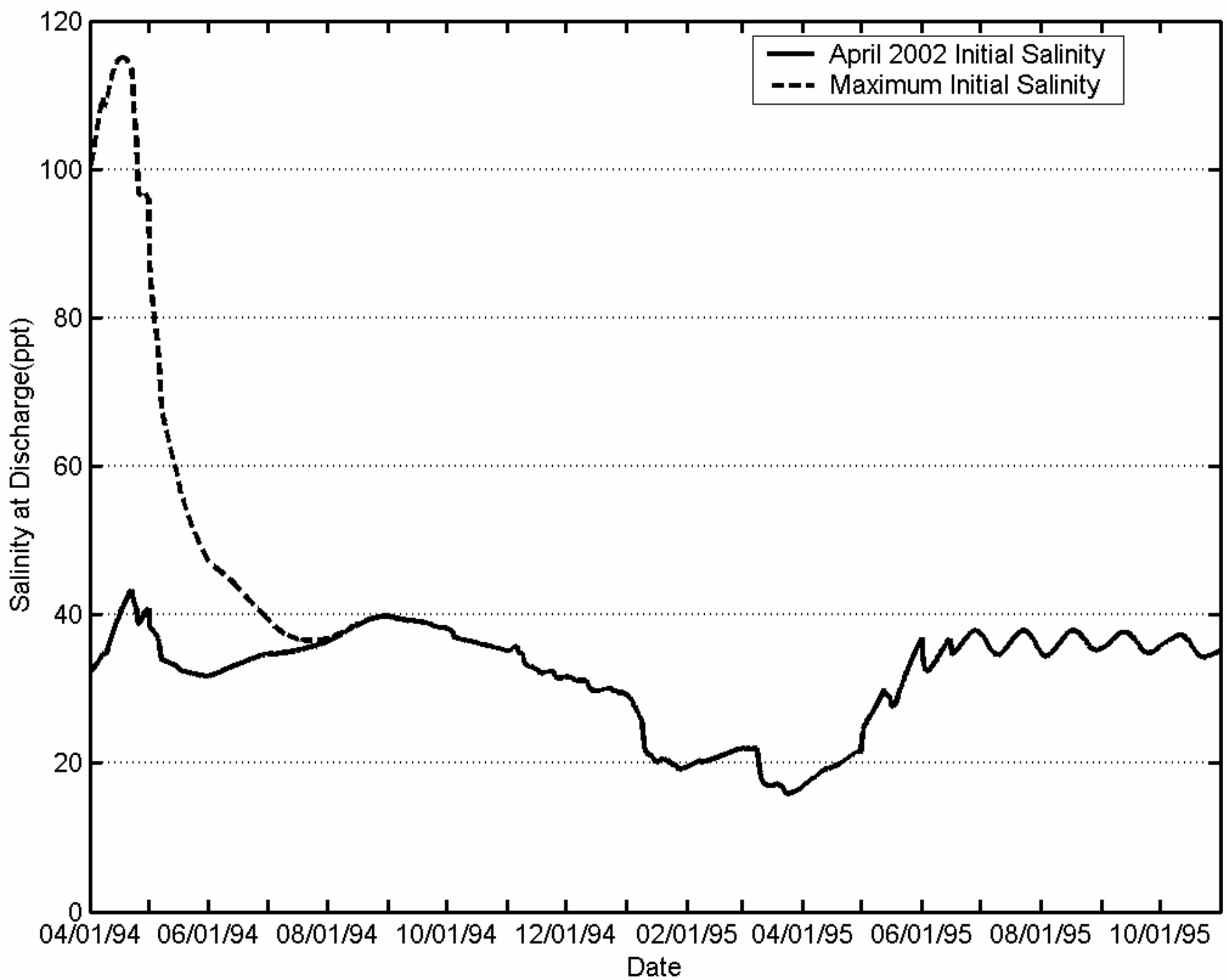


Figure 8. Predicted Salinity Profile for the Baumberg 8A Discharge

(based on 1994-95 weather conditions, tidal conditions, and bay salinity at intakes;
proposed infrastructure and system operation)

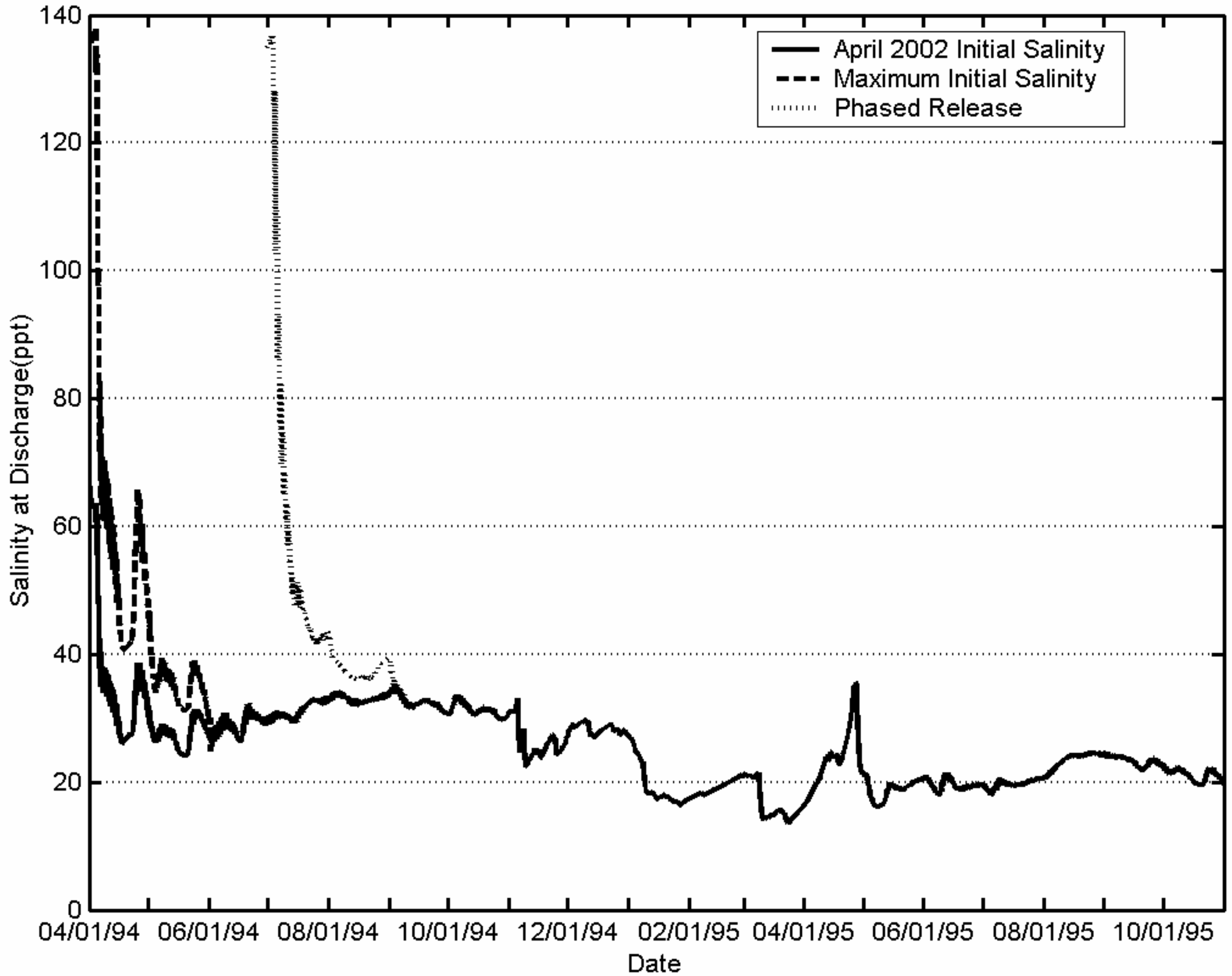


Figure 9. Predicted Salinity Profile for the Baumberg 11 Discharge

(based on 1994-95 weather conditions, tidal conditions, and bay salinity at intakes;
proposed infrastructure and system operation)

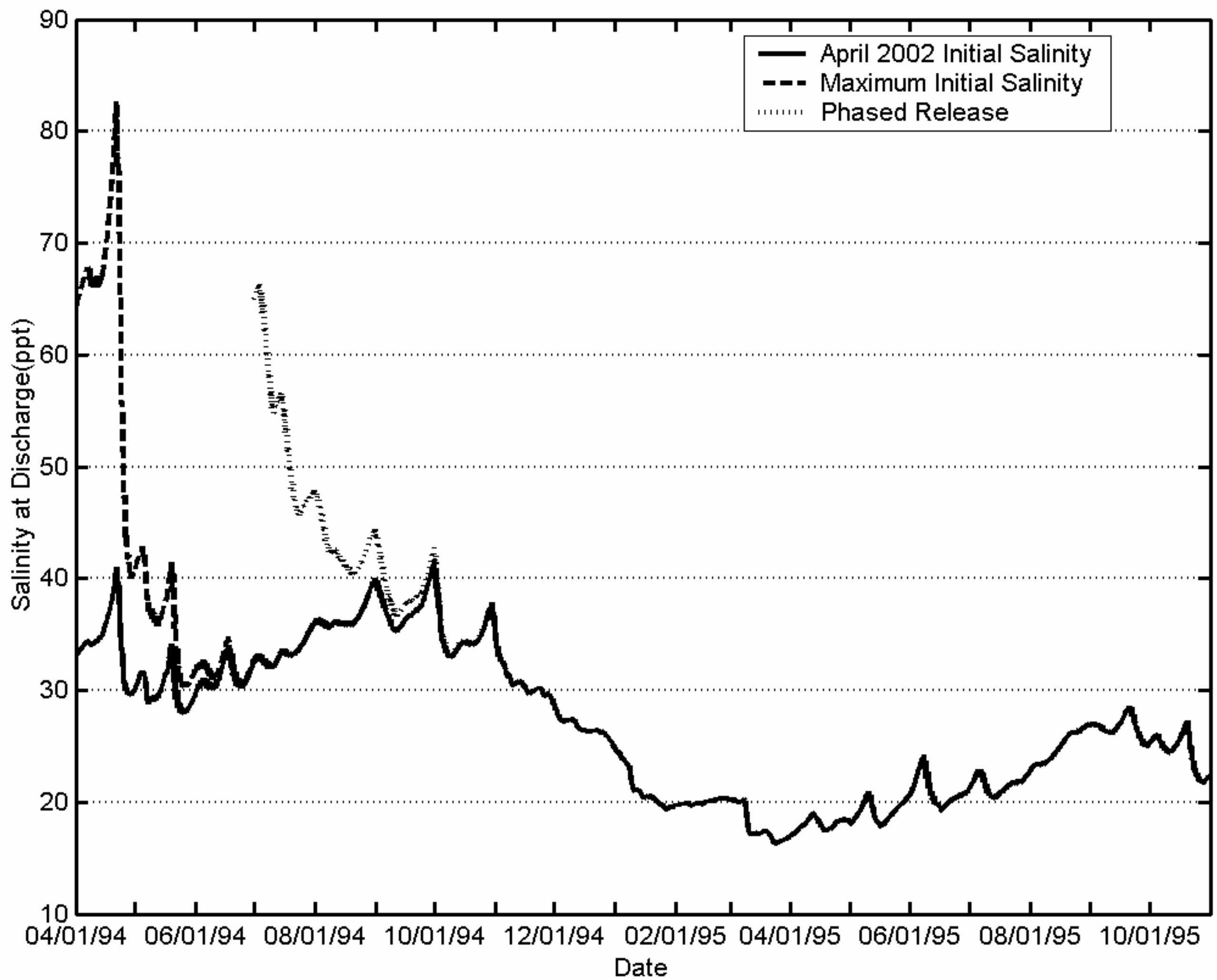


Figure 10. Predicted Salinity Profile for the Baumberg 6A Discharge

(based on 1994-95 weather conditions, tidal conditions, and bay salinity at intakes;
proposed infrastructure and system operation)

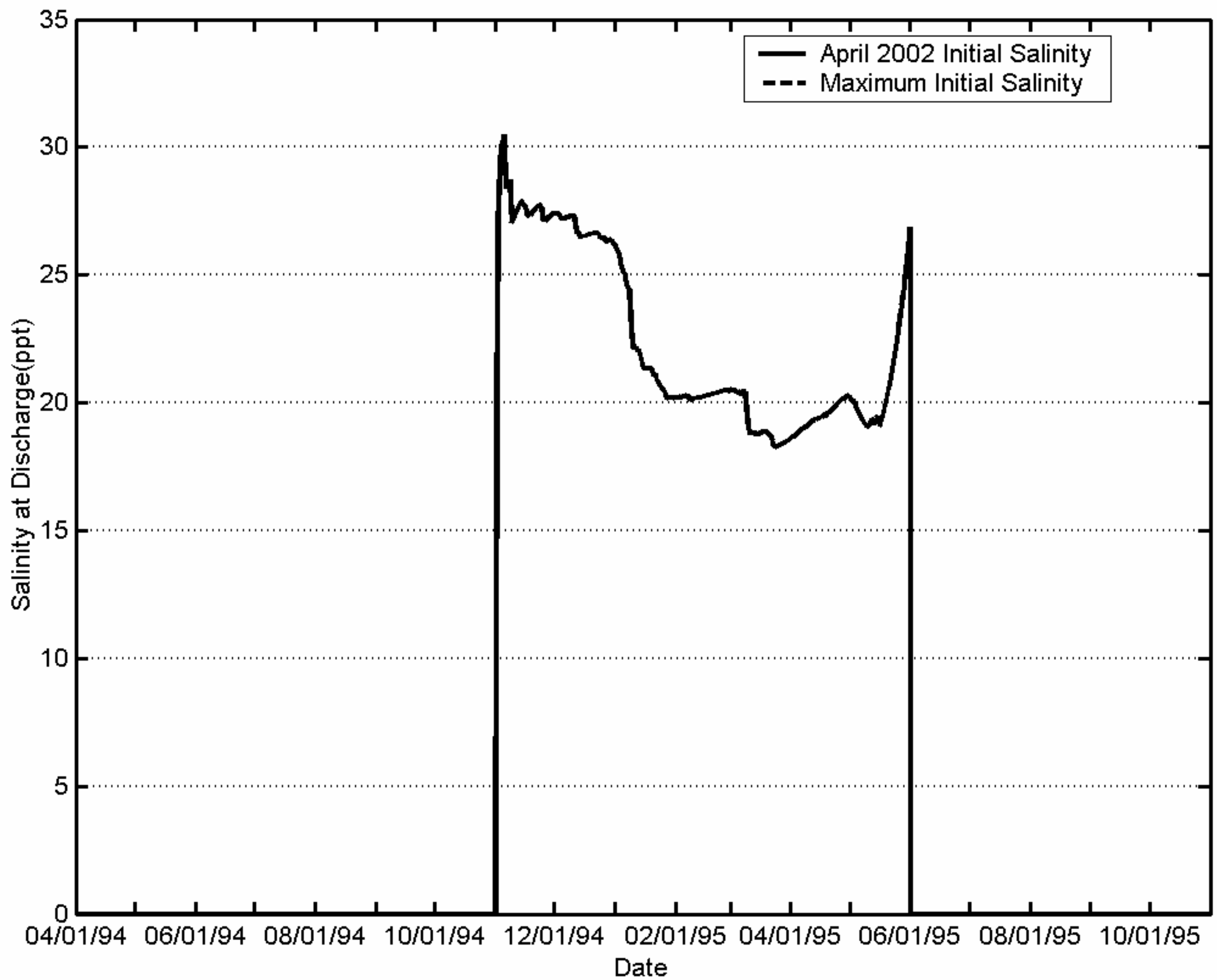


Figure 11. Predicted Salinity in S.F. Bay during **Initial Release Period**
(time of highest salinity elevations - after 6 weeks of discharge)
(assumes Initial Release Commences **April 1** at **2002 Salinity Values**)

Note: Salinity map of South San Francisco Bay indicates predicted depth-averaged and daily-averaged sainity in each grid cell of the hydrodynamic model. Predicted based on 1994 and 1995 weather and tidal conditions.

Existing | Initial Stewardship | Difference

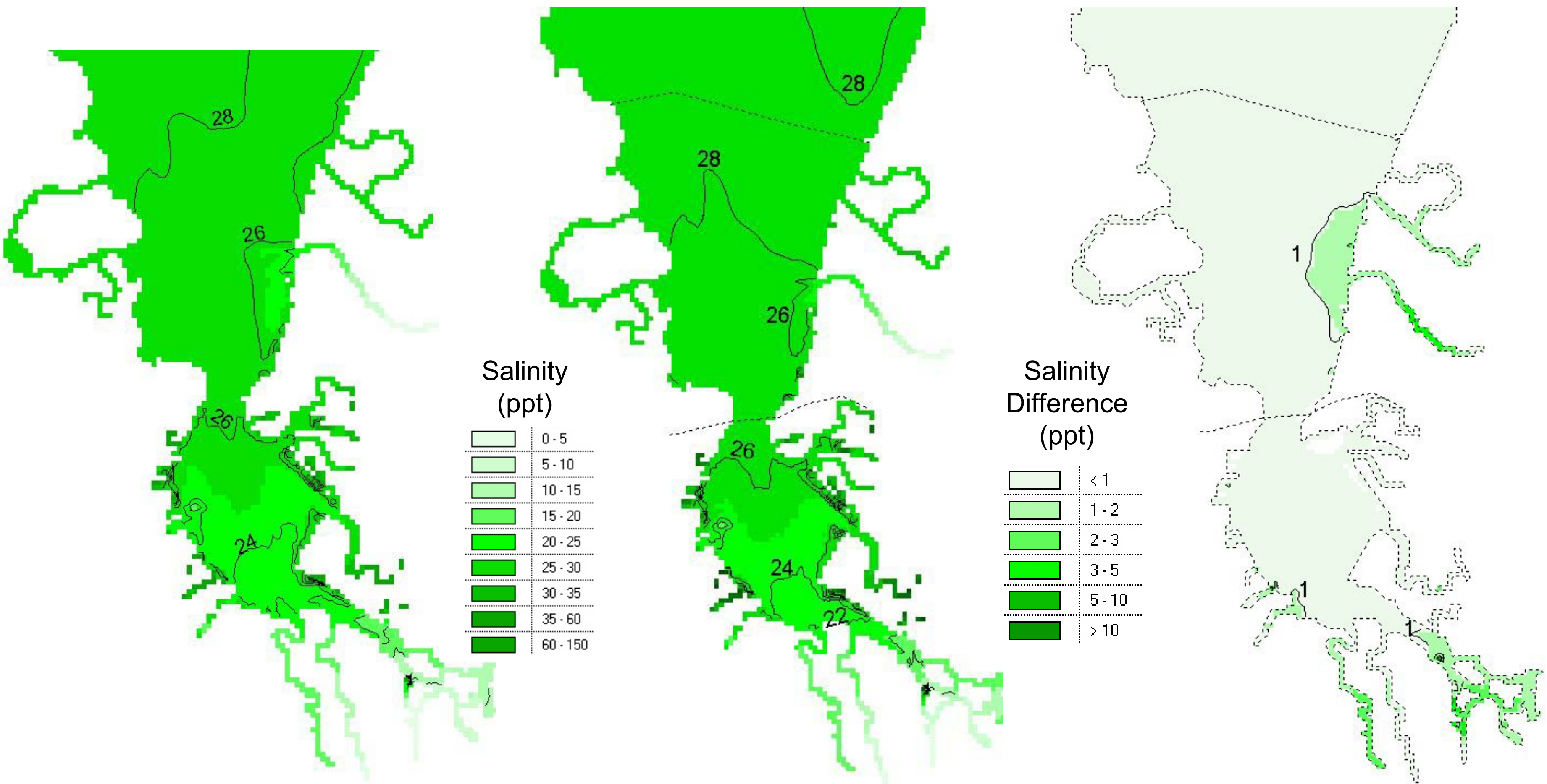
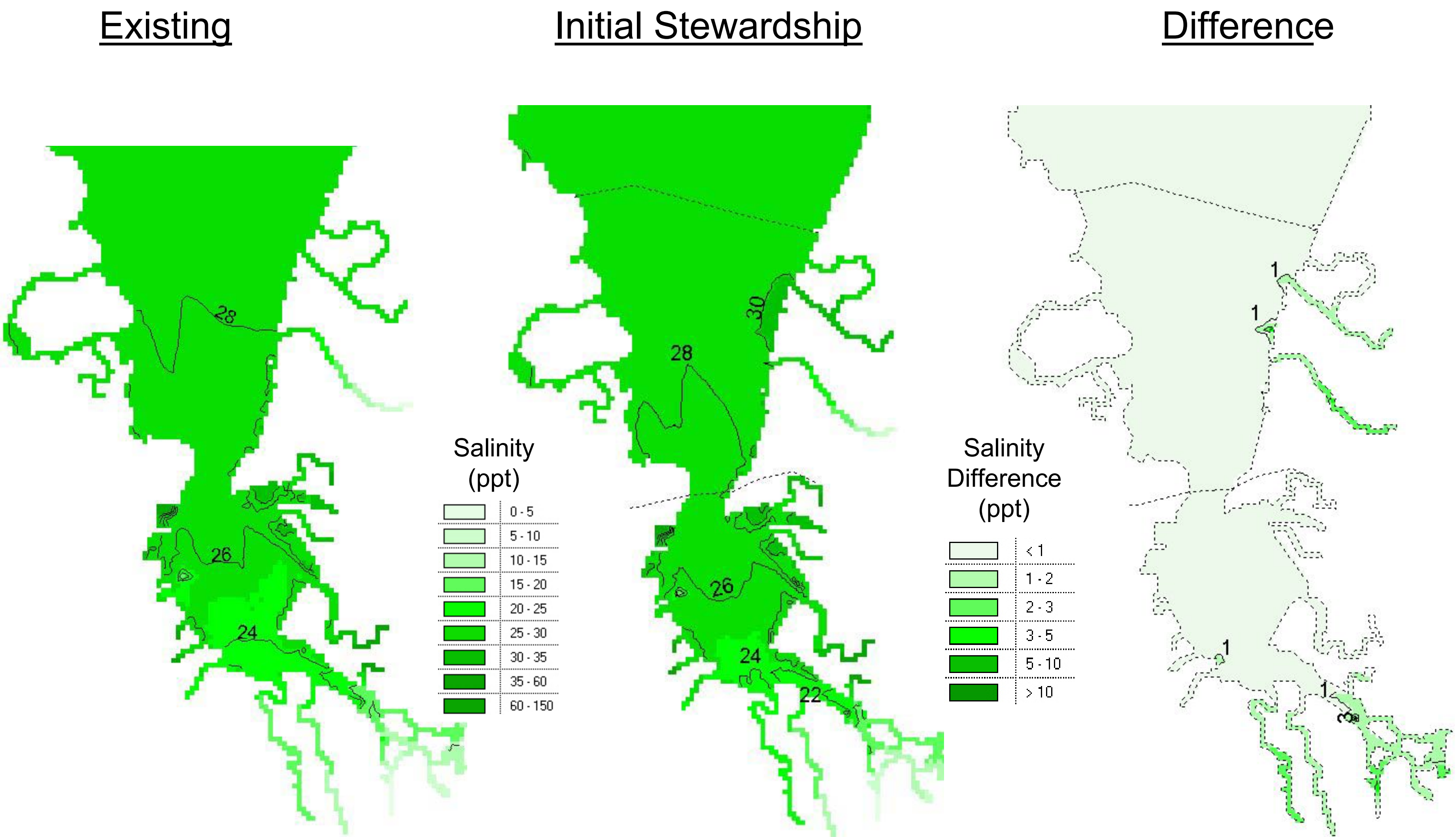
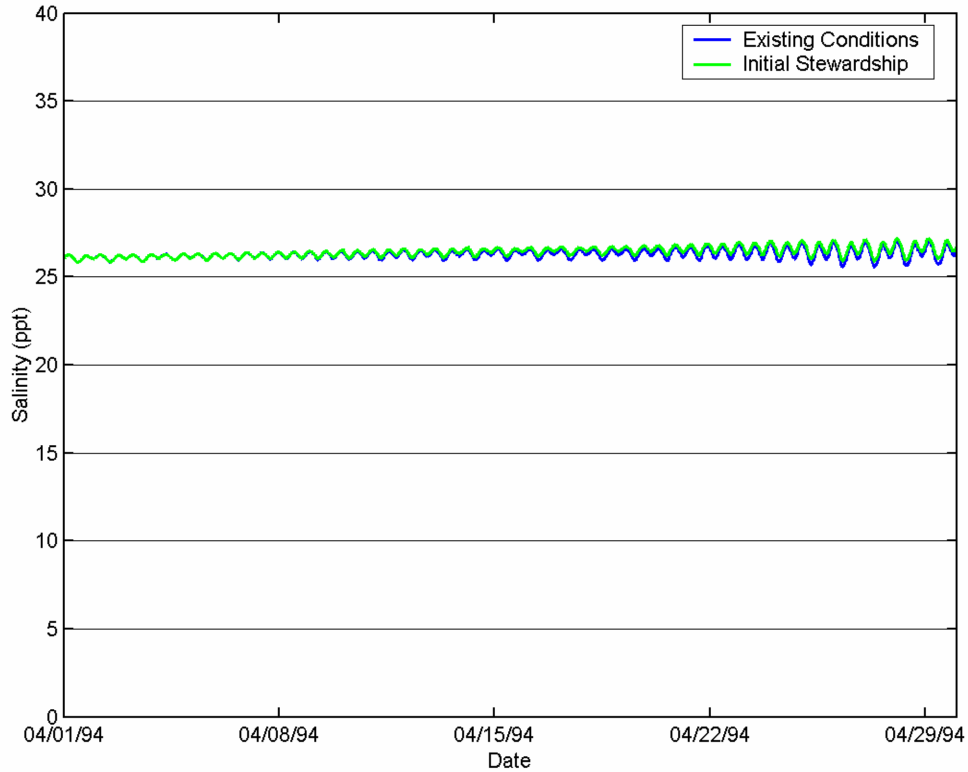


Figure 12. Predicted Salinity in S.F. Bay at End of **Initial Release Period**
(after 8 weeks of discharge)
(assumes Initial Release Commences **April 1** at **2002 Salinity Values**)

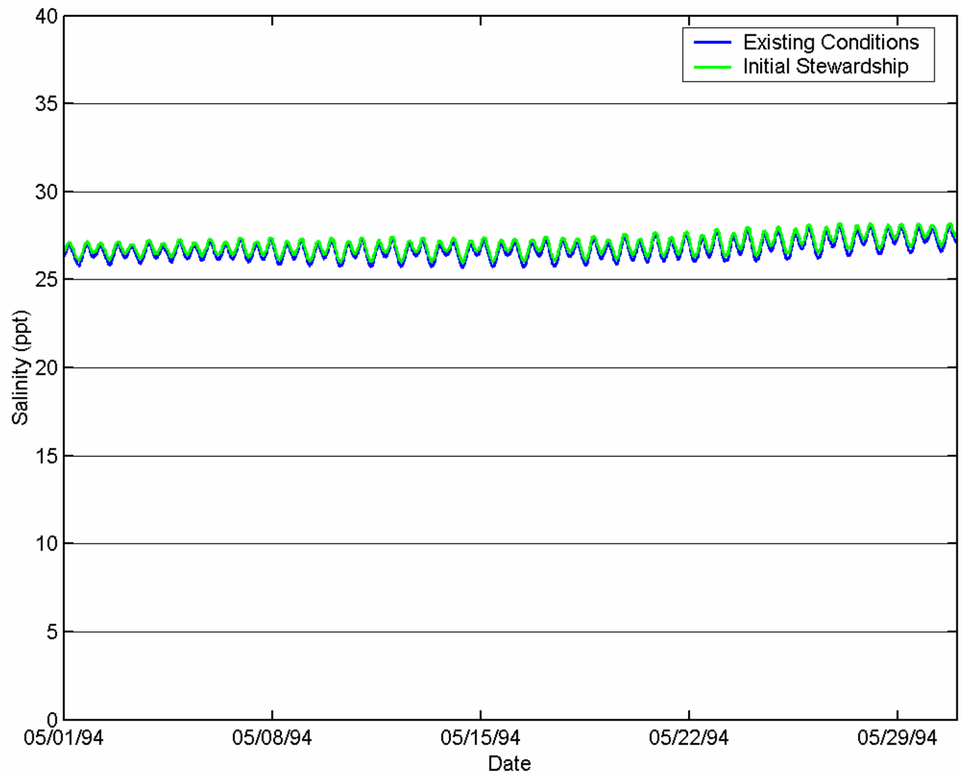
Note: Salinity map of South San Francisco Bay indicates predicted depth-averaged and daily-averaged sainity in each grid cell of the hydrodynamic model. Predicted based on 1994 and 1995 weather and tidal conditions.





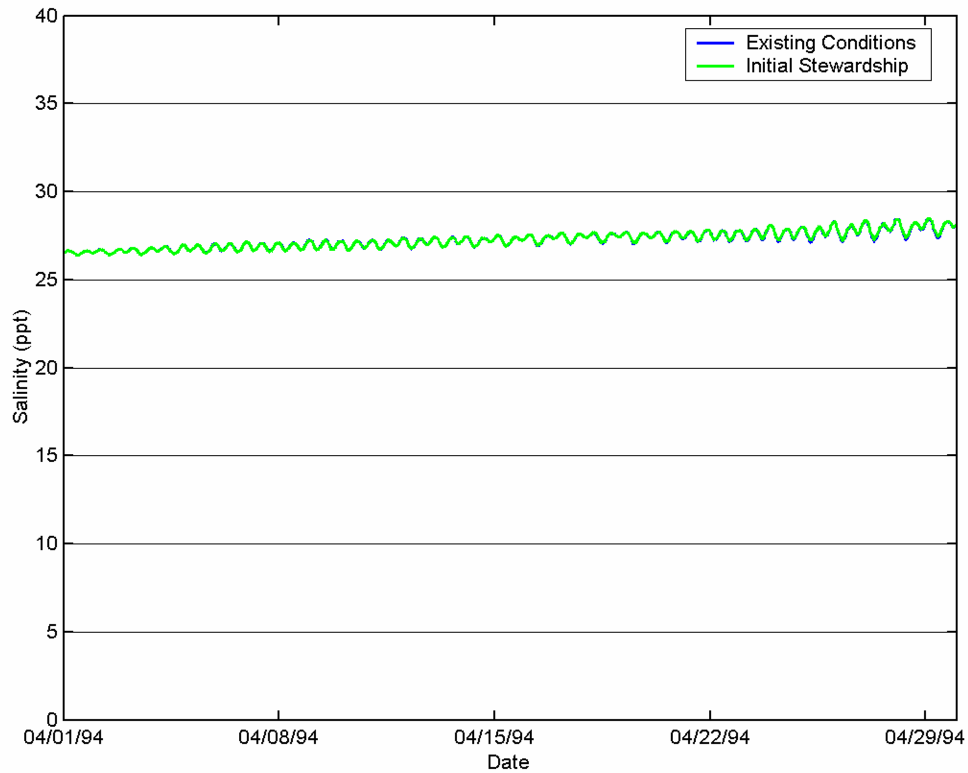
Note: Depth-averaged salinity predicted in the main channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 13. Predicted Salinity at the Dumbarton Bridge during the First Month of the Initial Release Period (Commencing April 1). Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at 2002 Salinity Values".



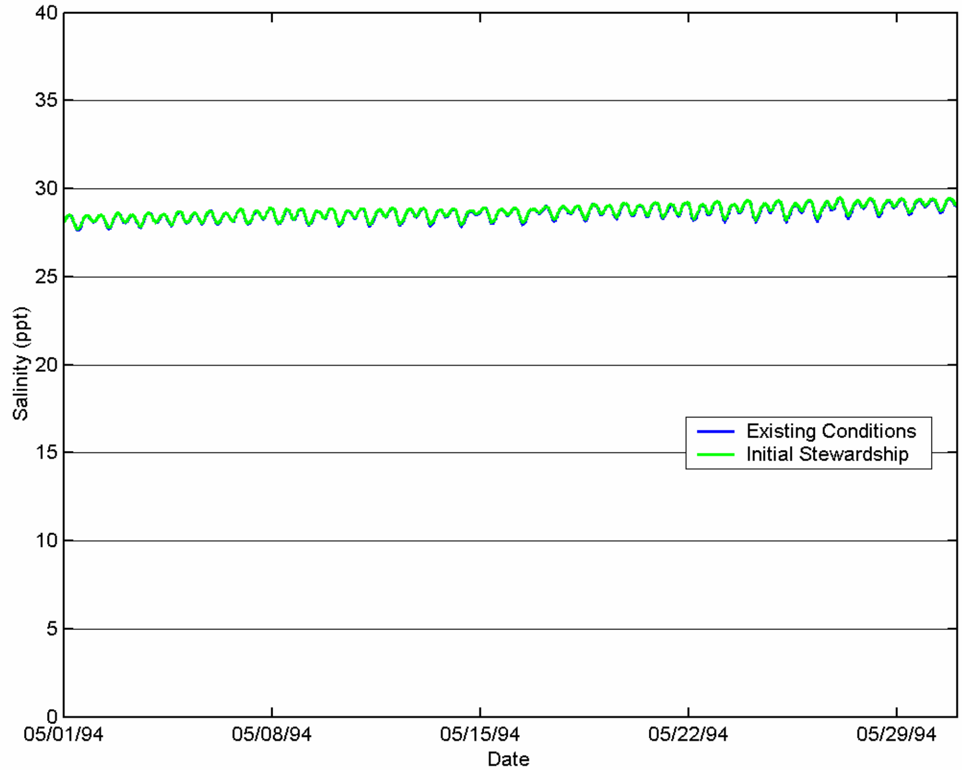
Note: Depth-averaged salinity predicted in the main channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 14. Predicted Salinity at the Dumbarton Bridge during the First Month of the Initial Release Period (Commencing April 1). Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at 2002 Salinity Values”.



Note: Depth-averaged salinity predicted in the main channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 15. Predicted Salinity at the San Mateo Bridge during the First Month of the Initial Release Period (Commencing April 1). Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at 2002 Salinity Values”.



Note: Depth-averaged salinity predicted in the main channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 16. Predicted Salinity at the San Mateo Bridge during the Second Month of the Initial Release Period (Commencing April 1). Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at 2002 Salinity Values".

Figure 17. Predicted Salinity in S.F. Bay during **Initial Release Period**
(time of highest salinity elevations - after 6 weeks of discharge)
(assumes Initial Release Commences **April 1** at **Proposed Maximum Salinity Values**)

Note: Salinity map of South San Francisco Bay indicates predicted depth-averaged and daily-averaged sainity in each grid cell of the hydrodynamic model. Predicted based on 1994 and 1995 weather and tidal conditions.

Existing

Initial Stewardship

Difference

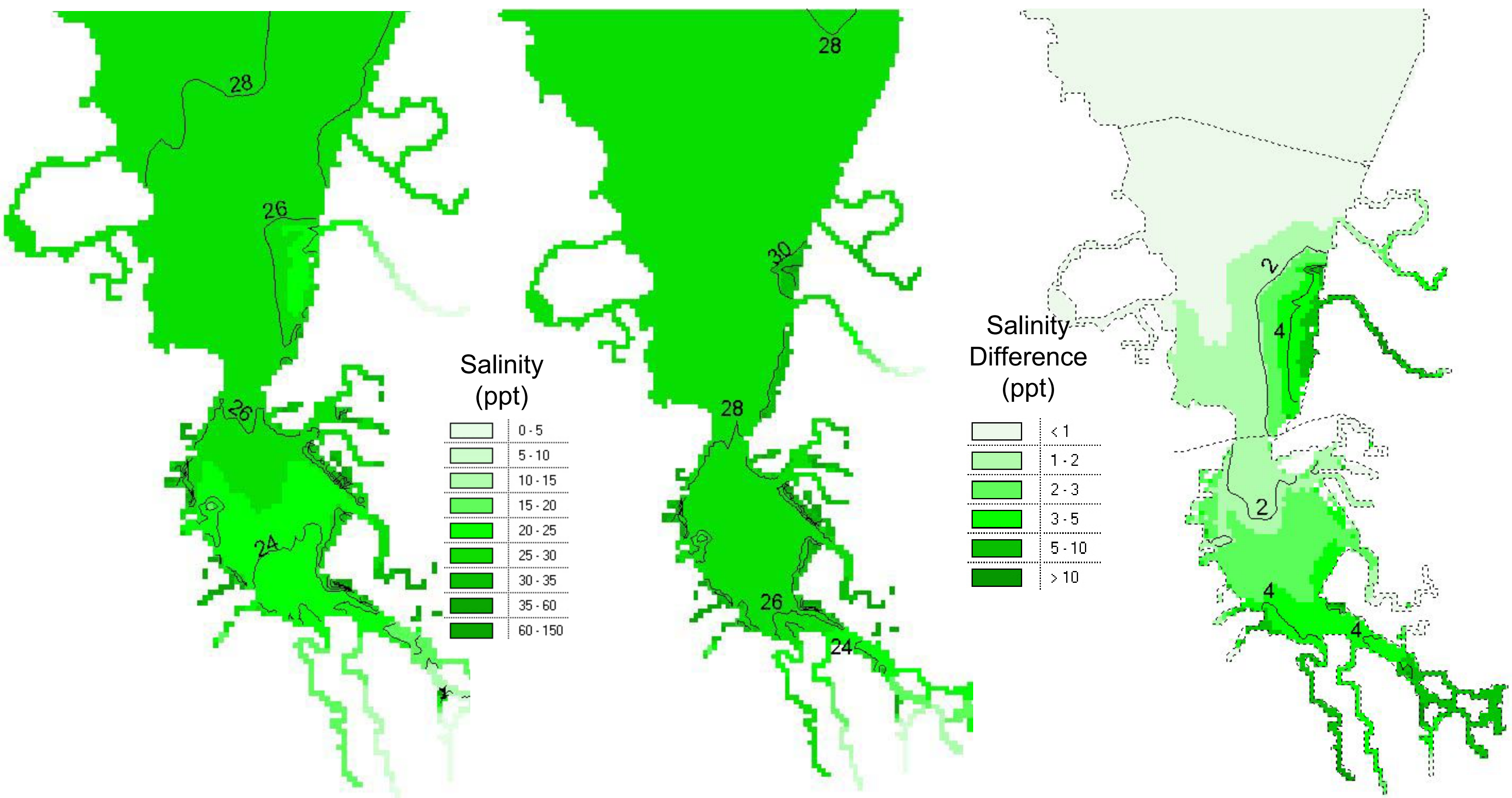
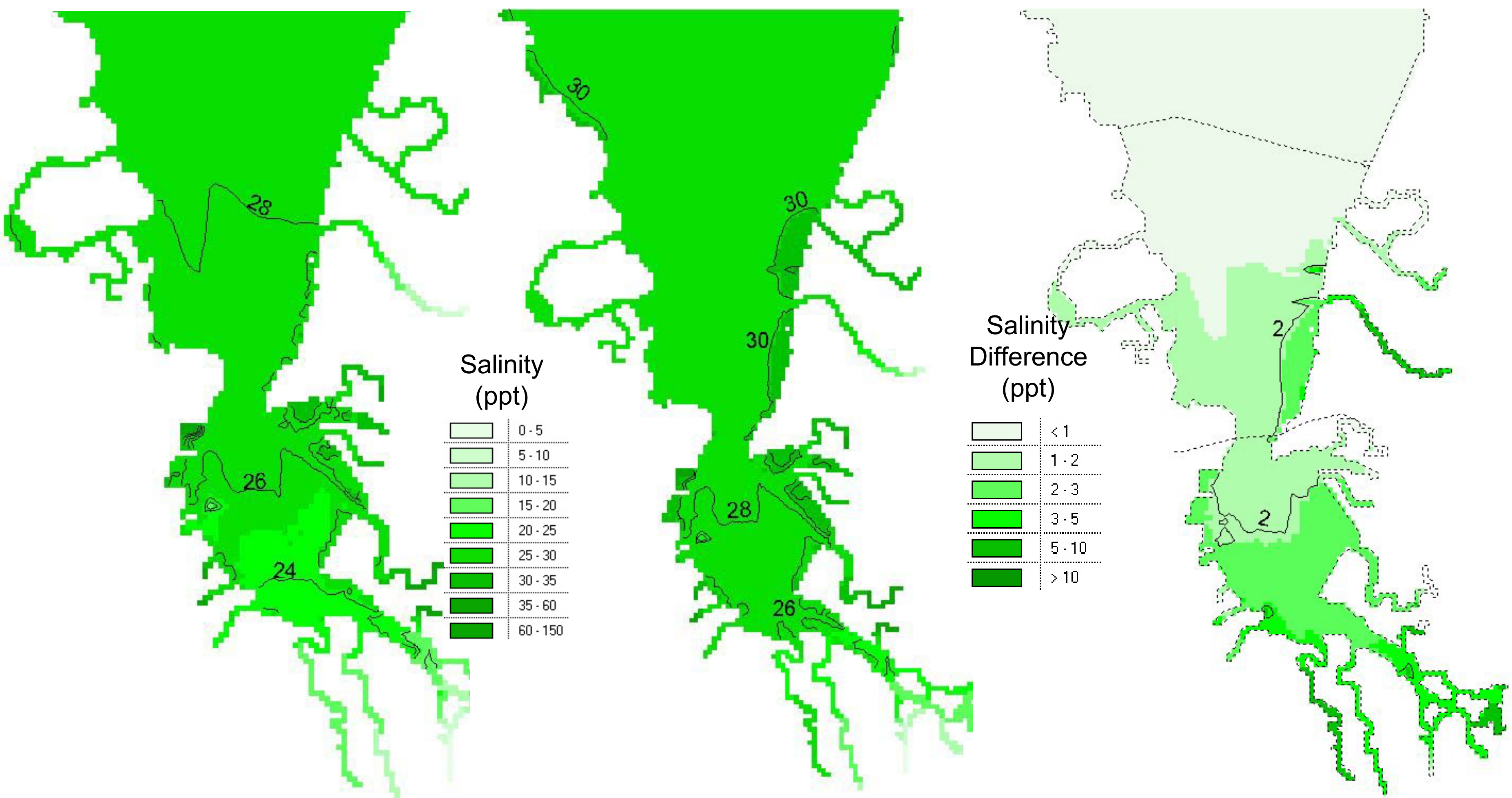
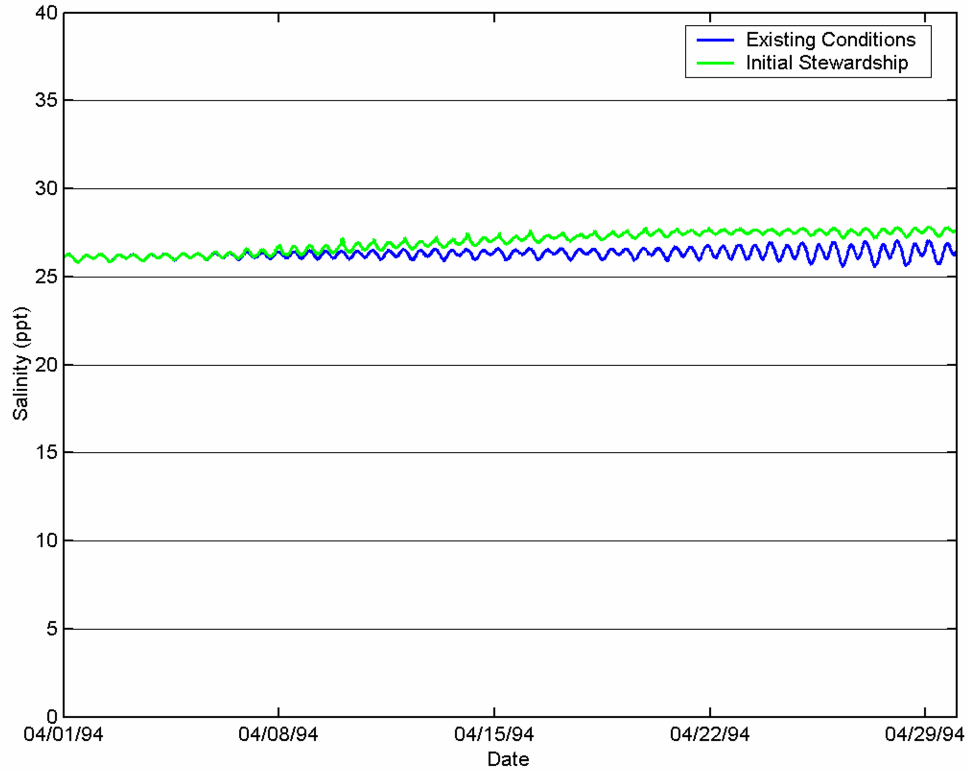


Figure 18. Predicted Salinity in S.F. Bay at End of **Initial Release Period**
(after 8 weeks of discharge)
(assumes Initial Release Commences **April 1** at **Proposed Maximum Salinity Values**)

Note: Salinity map of South San Francisco Bay indicates predicted depth-averaged and daily-averaged sainity in each grid cell of the hydrodynamic model. Predicted based on 1994 and 1995 weather and tidal conditions.

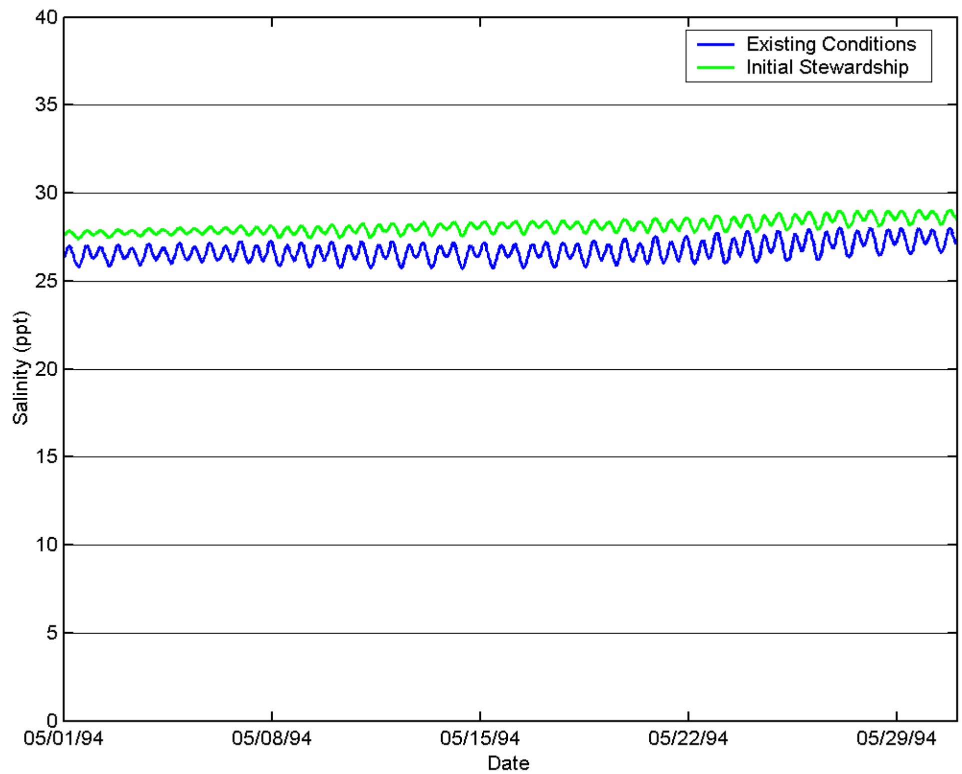
Existing | Initial Stewardship | Difference





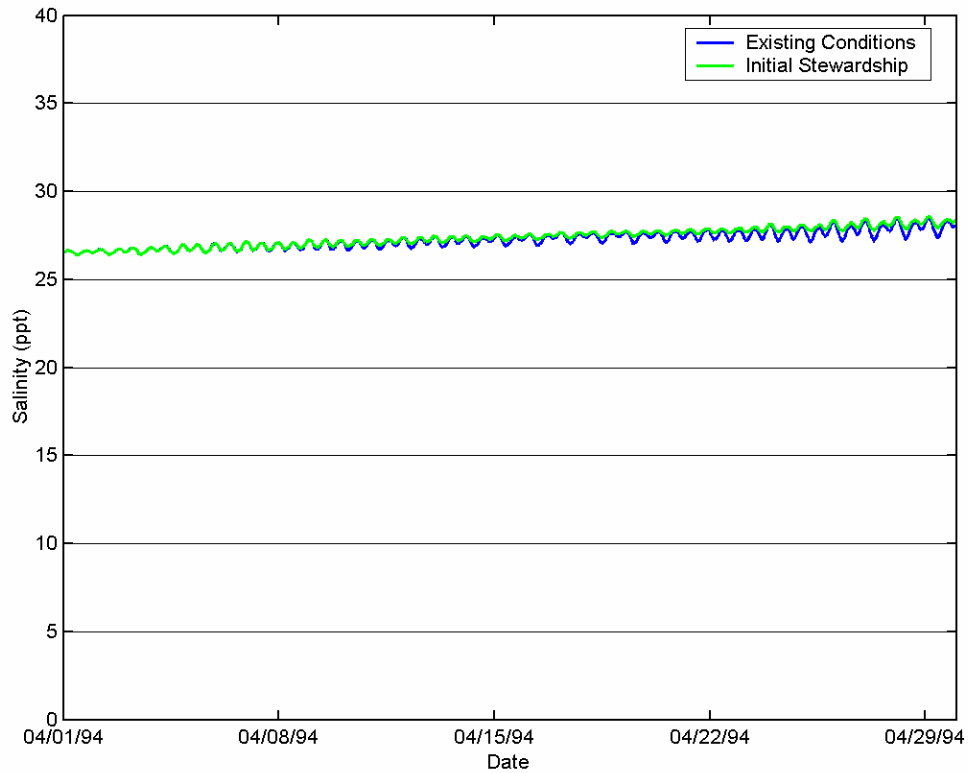
Note: Depth-averaged salinity predicted in the main channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 19. Predicted Salinity at the Dumbarton Bridge during the First Month of the Initial Release Period (Commencing April 1). Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values”.



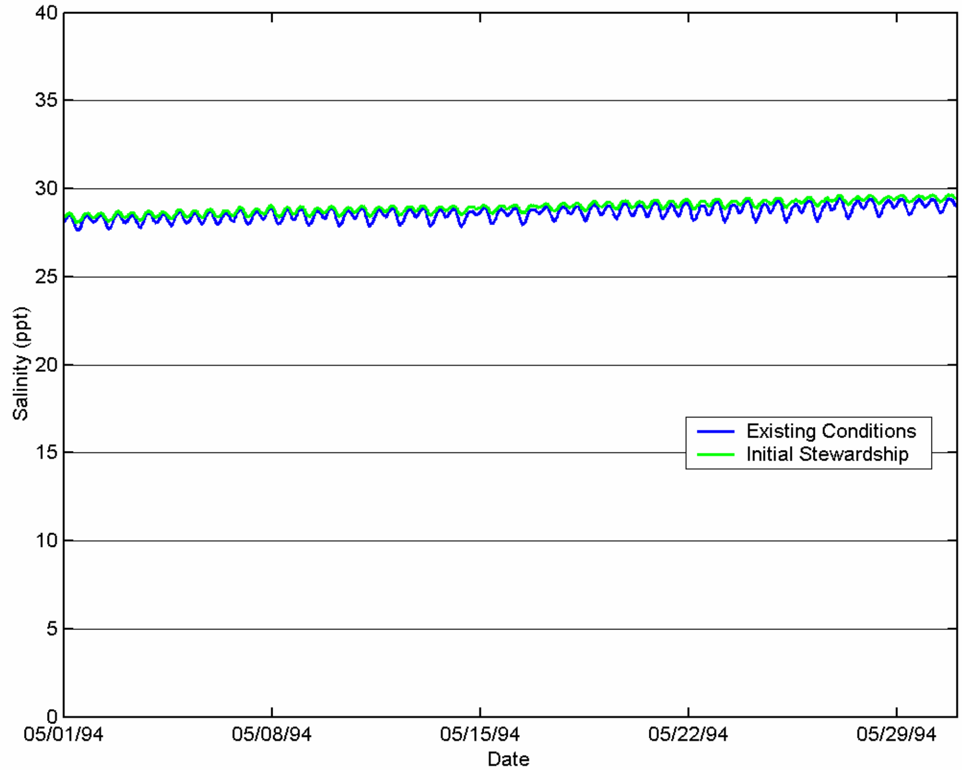
Note: Depth-averaged salinity predicted in the main channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 20. Predicted Salinity at the Dumbarton Bridge during the Second Month of the Initial Release Period (Commencing April 1). Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".



Note: Depth-averaged salinity predicted in the main channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 21. Predicted Salinity at the San Mateo Bridge during the First Month of the Initial Release Period (Commencing April 1). Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".



Note: Depth-averaged salinity predicted in the main channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 22. Predicted Salinity at the San Mateo Bridge during the Second Month of the Initial Release Period (Commencing April 1). Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values”.

Figure 23. Predicted Salinity in S.F. Bay during **Phased Initial Release Period**
(time of highest salinity elevations - after 1 week of discharge)
(assumes Initial Release Commences **July 1** at **Proposed Maximum Salinity Values**)

Note: Salinity map of South San Francisco Bay indicates predicted depth-averaged and daily-averaged sainity in each grid cell of the hydrodynamic model. Predicted based on 1994 and 1995 weather and tidal conditions.

Existing Initial Stewardship Difference

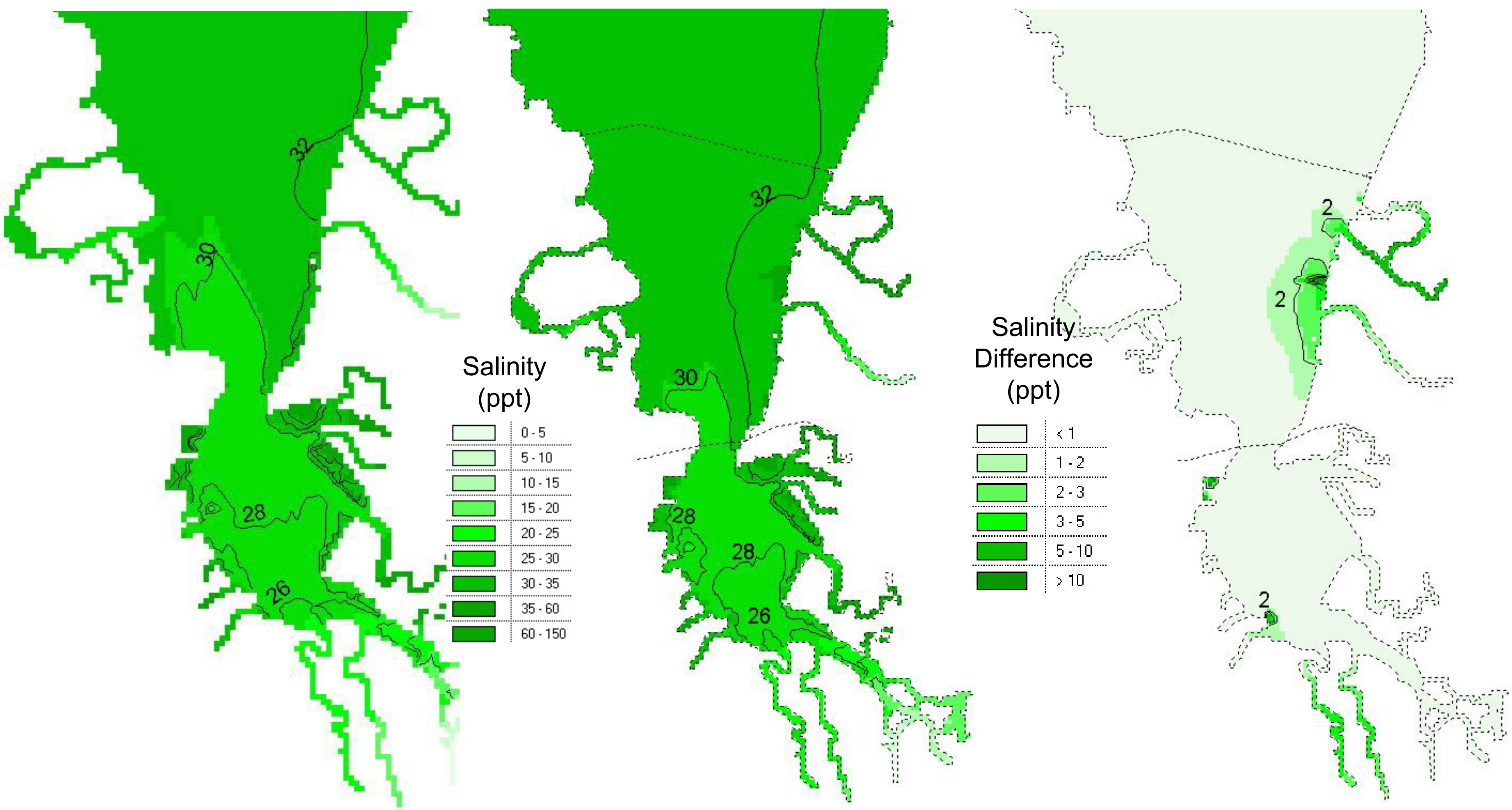


Figure 24. Predicted Salinity in S.F. Bay during **Phased Initial Release Period**
(time of highest salinity elevations - after 6 weeks of discharge)
(assumes Initial Release Commences **July 1** at **Proposed Maximum Salinity Values**)

Note: Salinity map of South San Francisco Bay indicates predicted depth-averaged and daily-averaged sainity in each grid cell of the hydrodynamic model. Predicted based on 1994 and 1995 weather and tidal conditions.

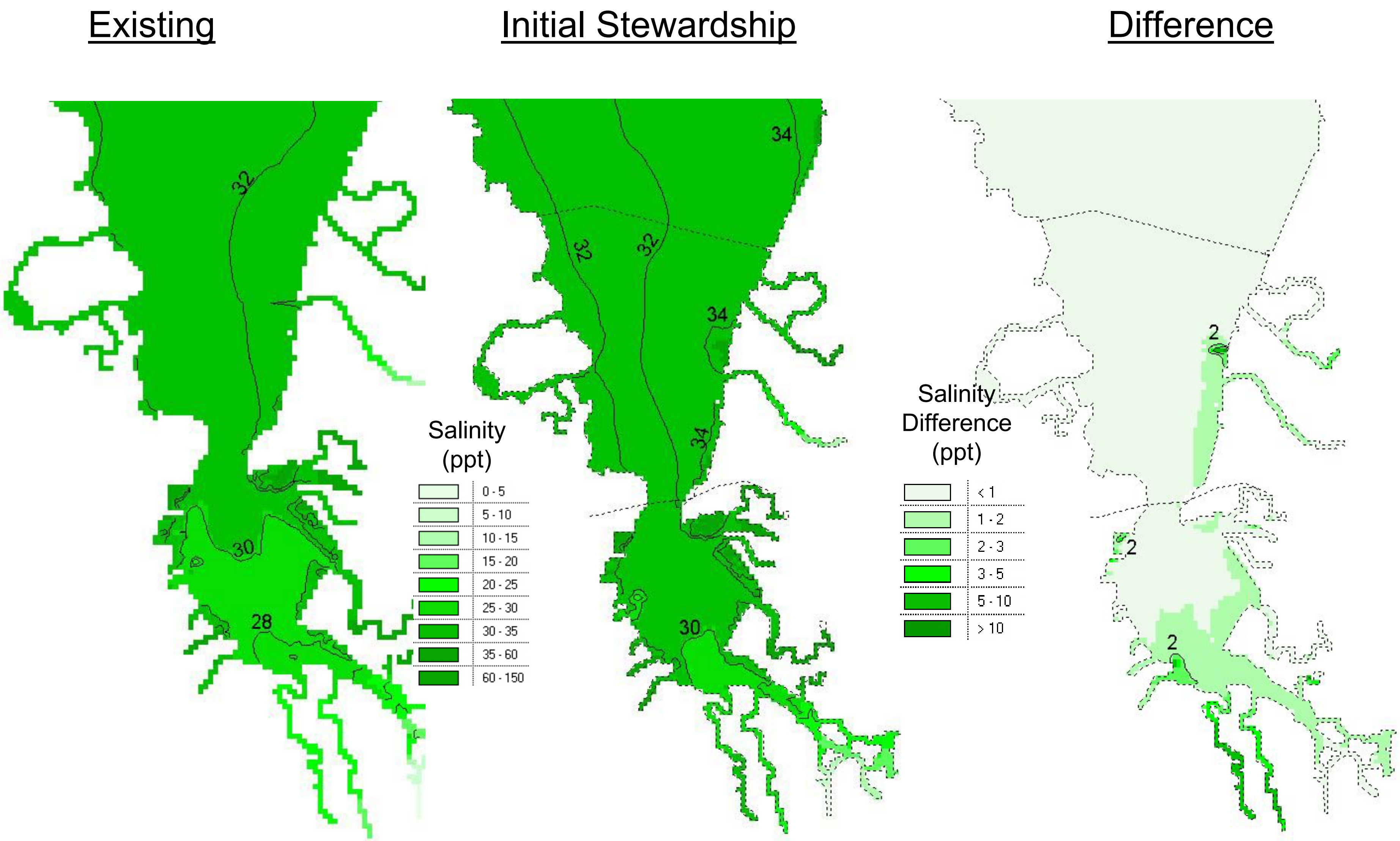
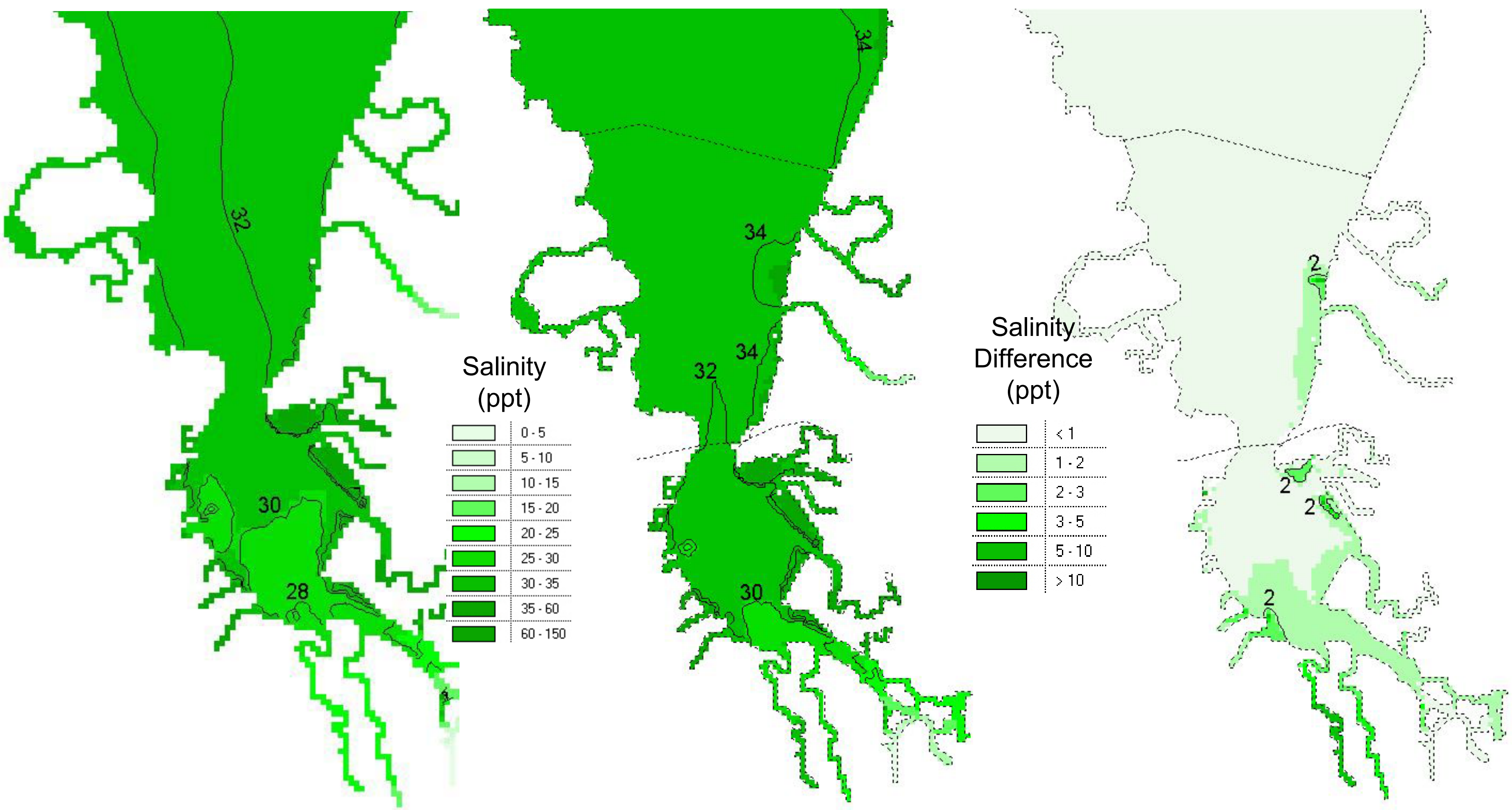
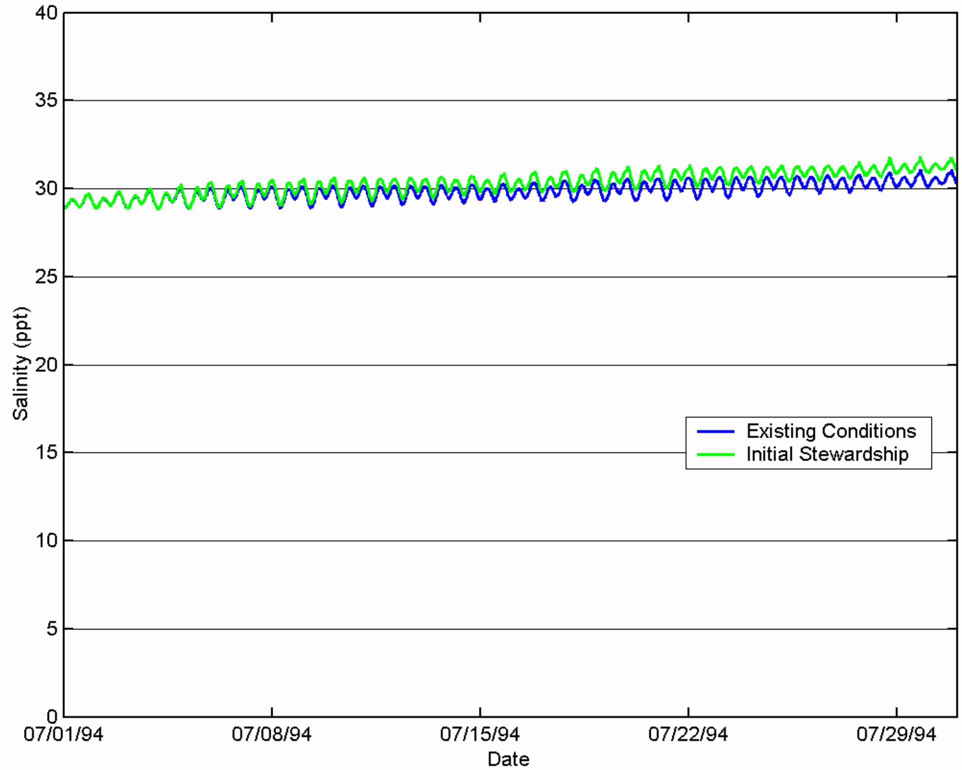


Figure 25. Predicted Salinity in S.F. Bay at End of **Phased Initial Release Period**
(after 8 weeks of discharge)
(assumes Initial Release Commences **July 1** at **Proposed Maximum Salinity Values**)

Note: Salinity map of South San Francisco Bay indicates predicted depth-averaged and daily-averaged sainity in each grid cell of the hydrodynamic model. Predicted based on 1994 and 1995 weather and tidal conditions.

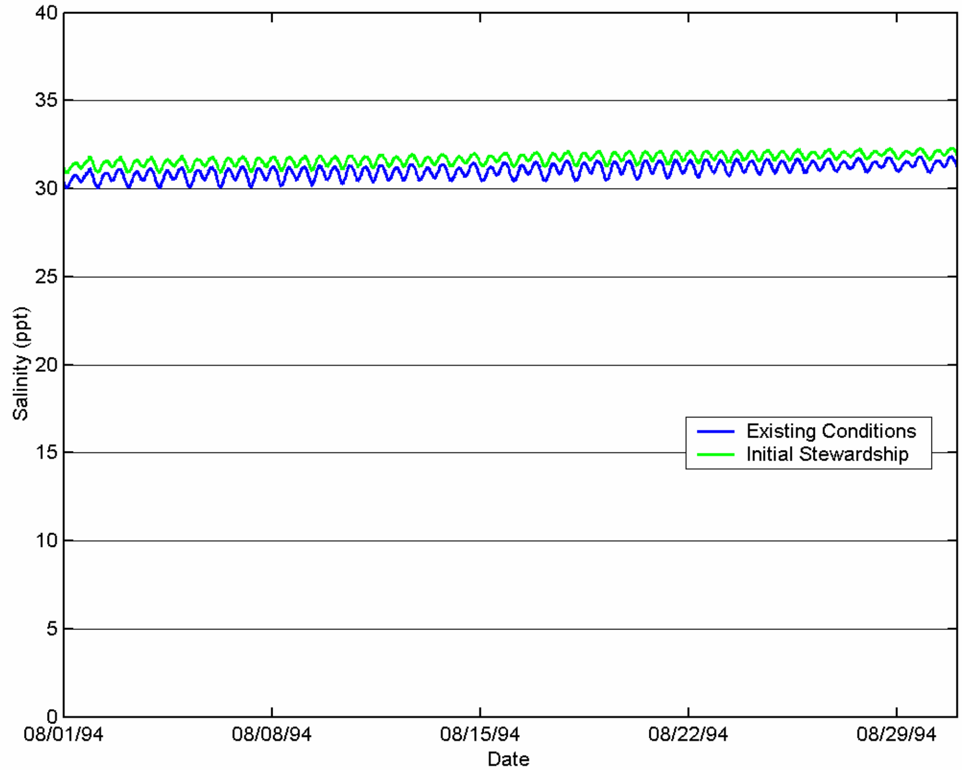
Existing | Initial Stewardship | Difference





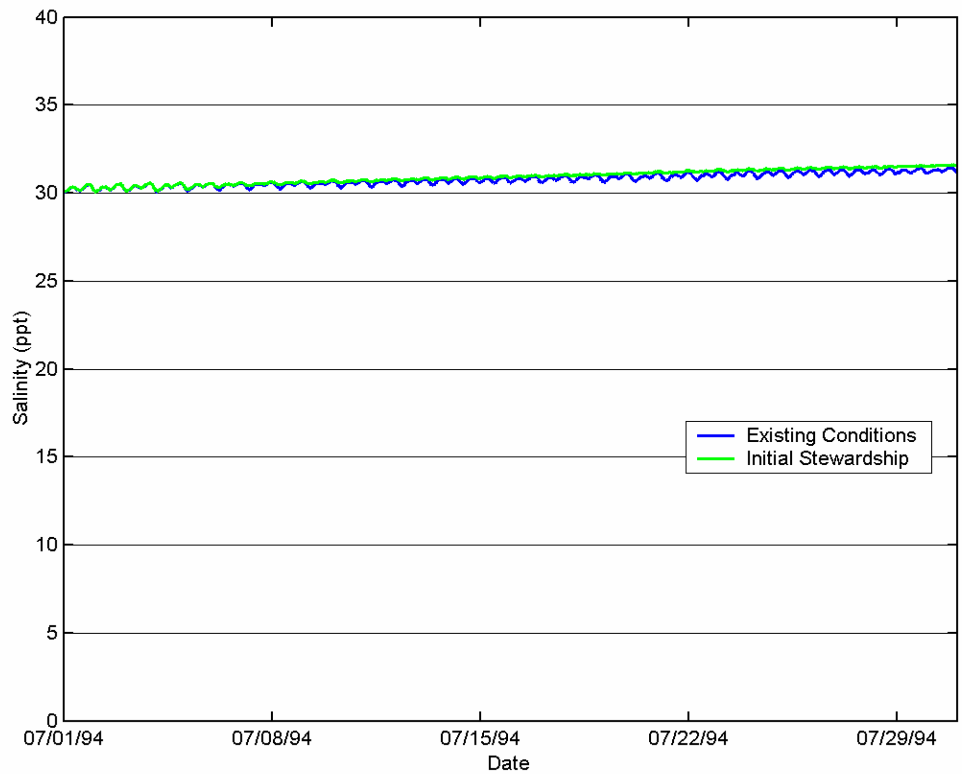
Note: Depth-averaged salinity predicted in the main channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 26. Predicted Salinity at the Dumbarton Bridge during the First Month of the Phased Initial Release Period (Commencing July 1). Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".



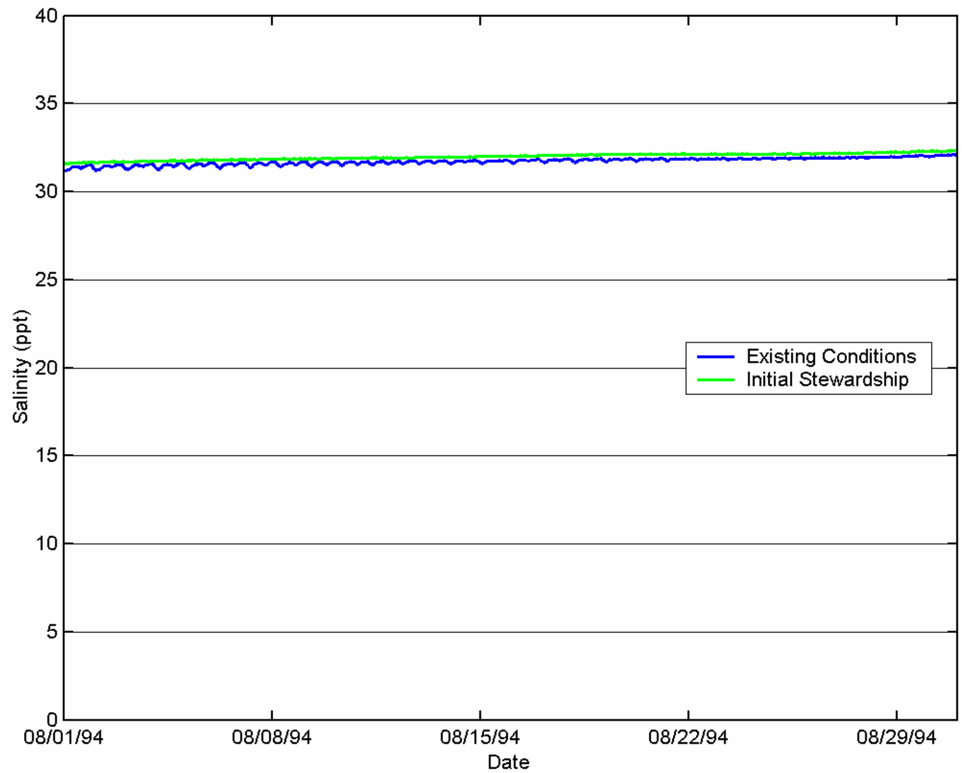
Note: Depth-averaged salinity predicted in the main channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 27. Predicted Salinity at the Dumbarton Bridge during the Second Month of the Phased Initial Release Period (Commencing July 1). Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".



Note: Depth-averaged salinity predicted in the main channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 28. Predicted Salinity at the San Mateo Bridge during the First Month of the Phased Initial Release Period (Commencing July 1). Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values”.



Note: Depth-averaged salinity predicted in the main channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 29. Predicted Salinity at the San Mateo Bridge during the Second Month of the Phased Initial Release Period (Commencing July 1). Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values”.

Figure 30. Predicted Salinity in S.F. Bay during **Continuous Circulation Period** (**Late Summer Dry Period**)

(based on 9/15/94 conditions and assumes Initial Release has been completed)

Note: Salinity map of South San Francisco Bay indicates predicted depth-averaged and daily-averaged sainity in each grid cell of the hydrodynamic model. Predicted based on 1994 and 1995 weather and tidal conditions.

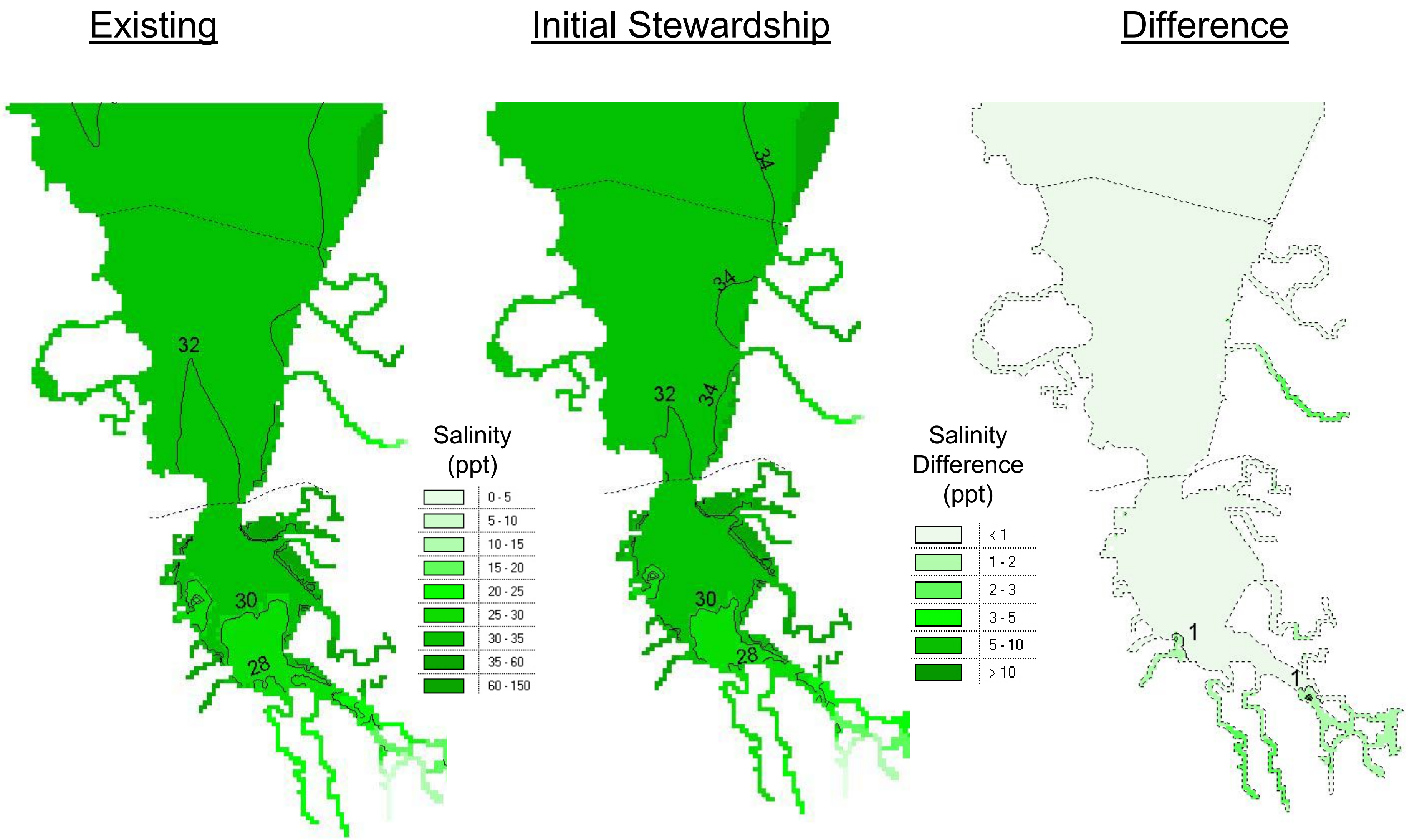


Figure 31. Predicted Salinity in S.F. Bay during **Continuous Circulation Period** (**mid-Winter Storm Event**)

(based on 2/20/95 conditions and assumes Initial Release has been completed)

Note: Salinity map of South San Francisco Bay indicates predicted depth-averaged and daily-averaged sainity in each grid cell of the hydrodynamic model. Predicted based on 1994 and 1995 weather and tidal conditions.

Existing | Initial Stewardship | Difference

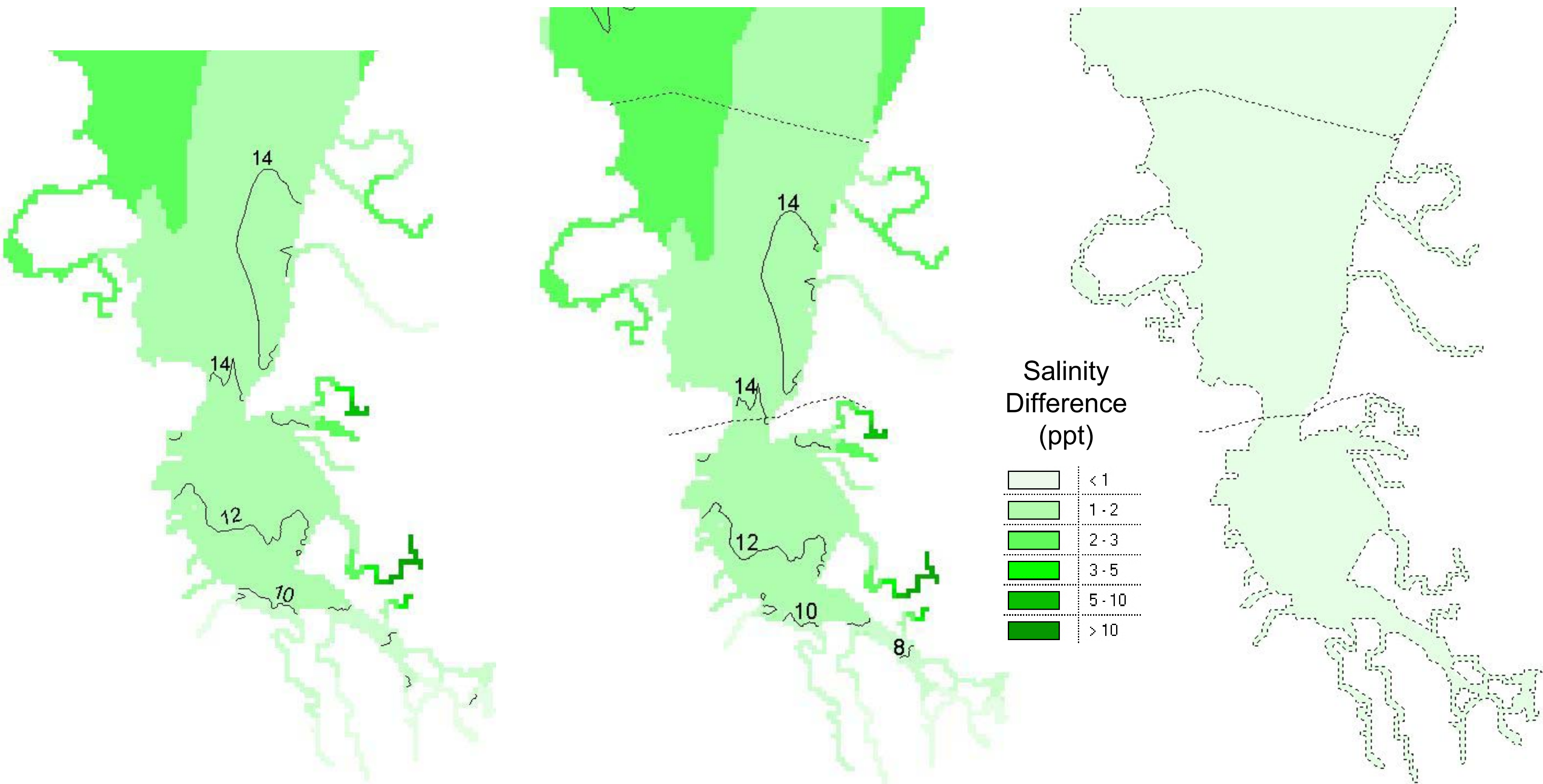


Figure 32. Predicted Salinity in S.F. Bay during **Continuous Circulation Period** (**mid-Winter Dry Period**)

(based on 3/10/95 conditions and assumes Initial Release has been completed)

Note: Salinity map of South San Francisco Bay indicates predicted depth-averaged and daily-averaged sainity in each grid cell of the hydrodynamic model. Predicted based on 1994 and 1995 weather and tidal conditions.

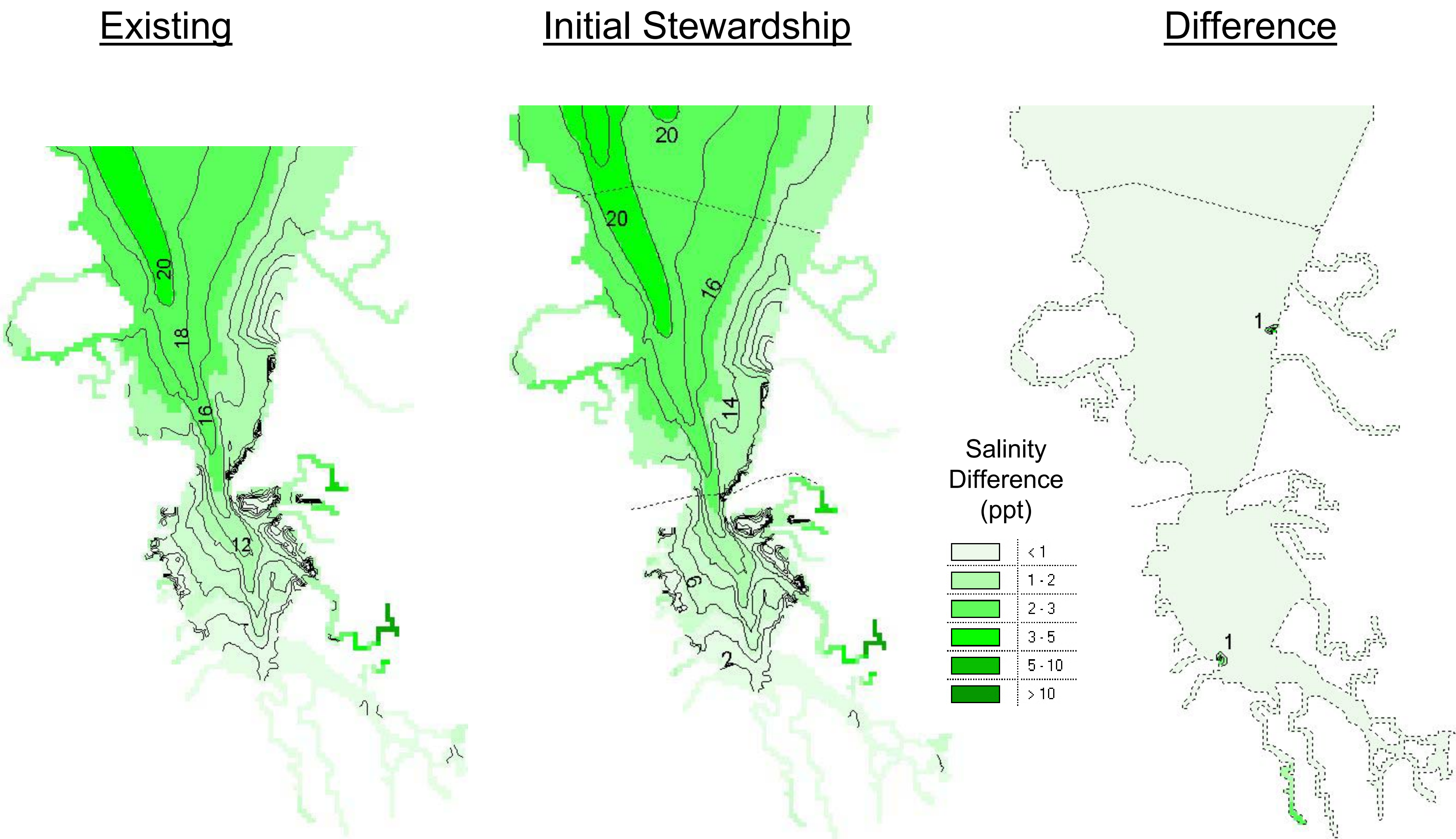


Figure 33. Predicted Salinity in S.F. Bay during **Continuous Circulation Period**
(**Spring of Subsequent Years**)
(based on 6/1/95 conditions and assumes Initial Release has been completed)

Note: Salinity map of South San Francisco Bay indicates predicted depth-averaged and daily-averaged sainity in each grid cell of the hydrodynamic model. Predicted based on 1994 and 1995 weather and tidal conditions.

Existing | Initial Stewardship | Difference

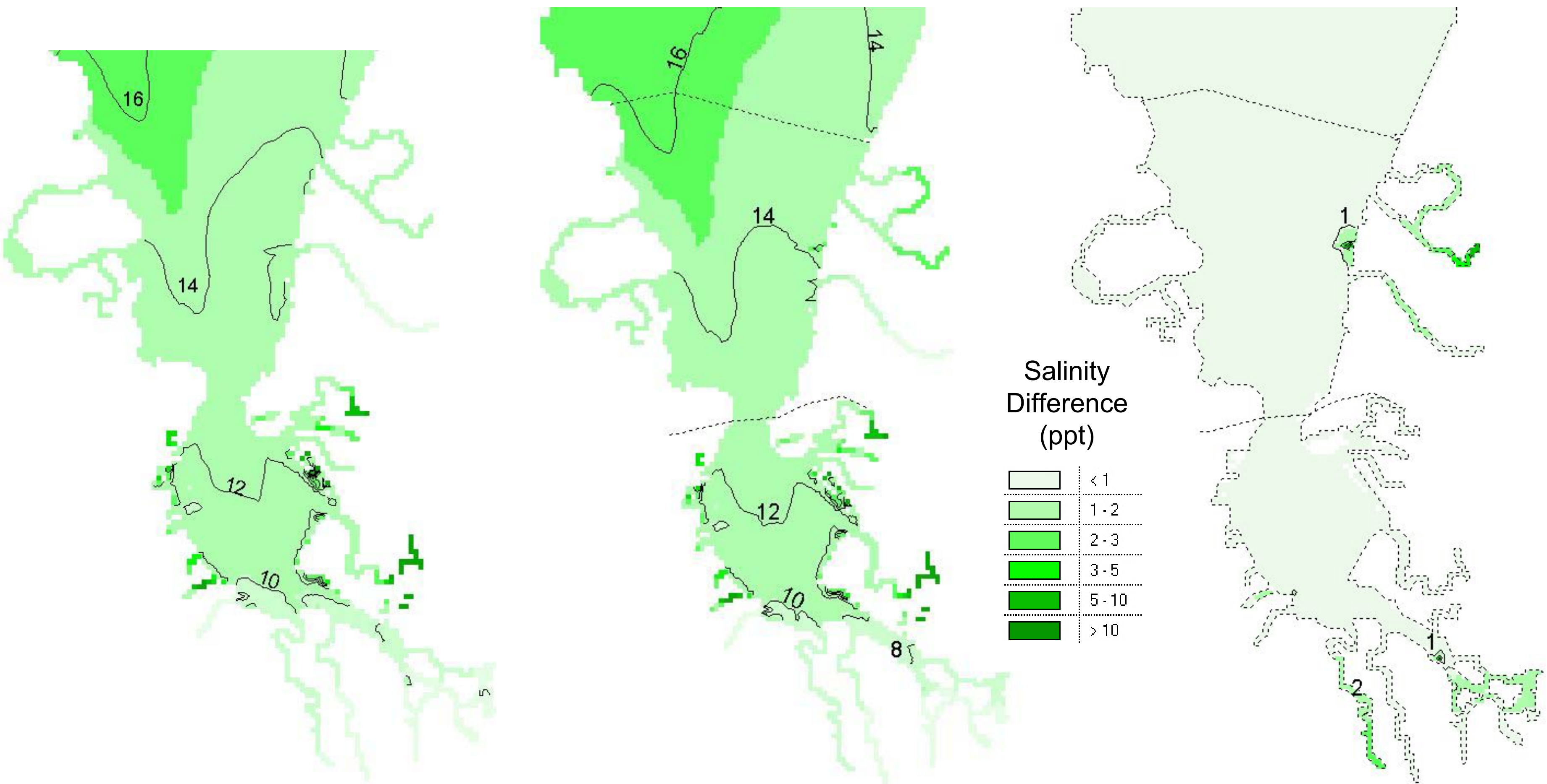
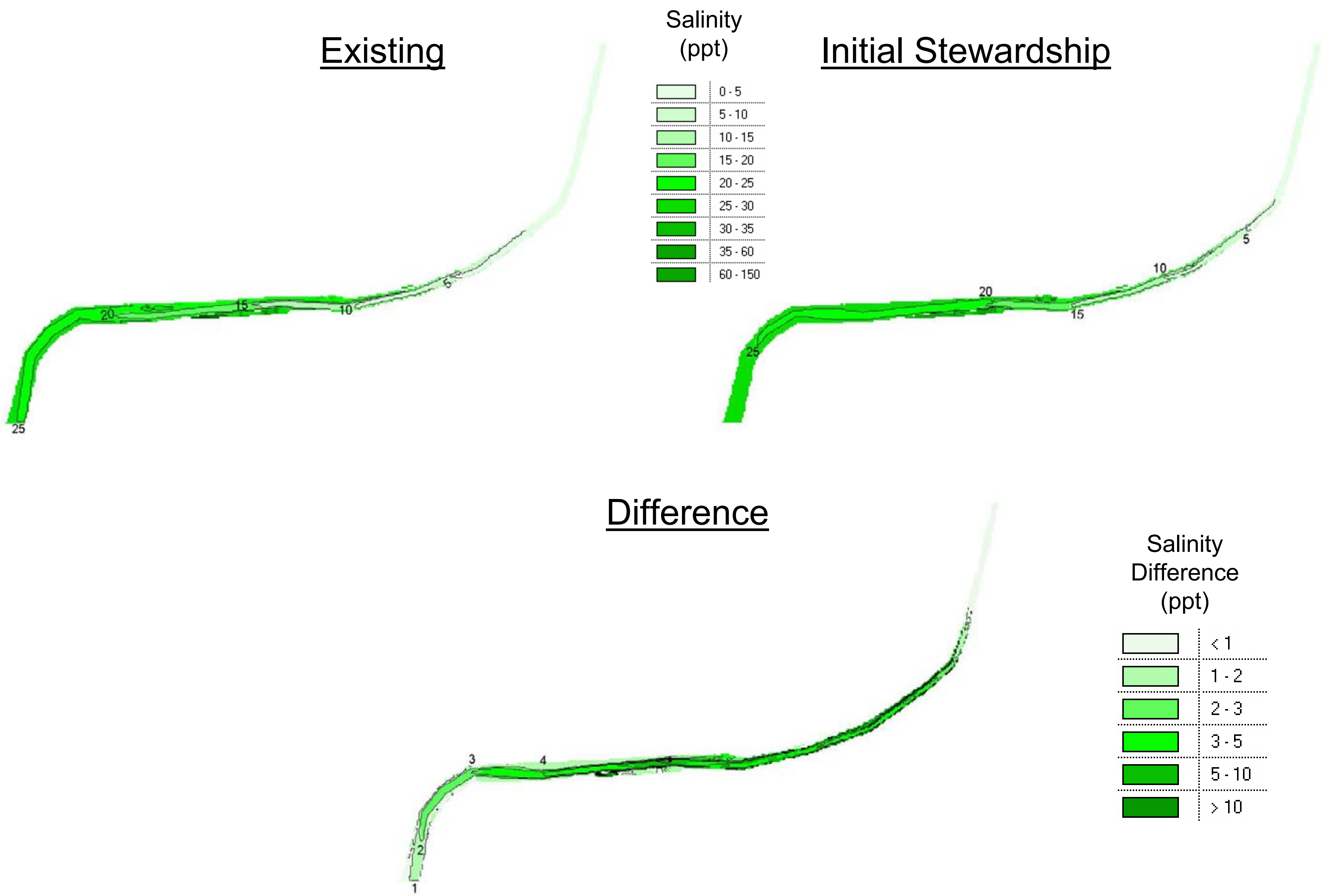
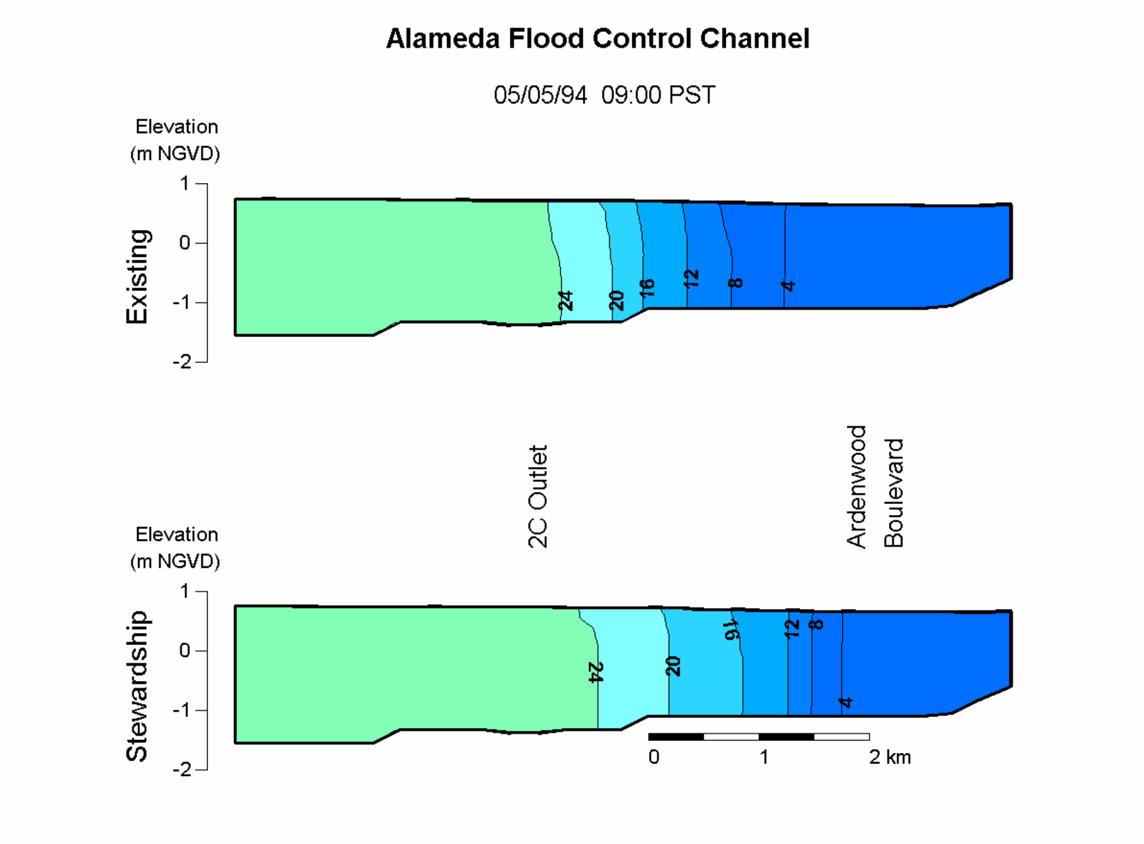


Figure 34. Distances along the Alameda Flood Control Channel – starting at its mouth and moving upstream.

Figure 35. Predicted Salinity in AFCC during **Initial Release Period** after 5 weeks of Discharge
((assumes Initial Release Commences **April1** at **2002 Salinity Values**)

Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.



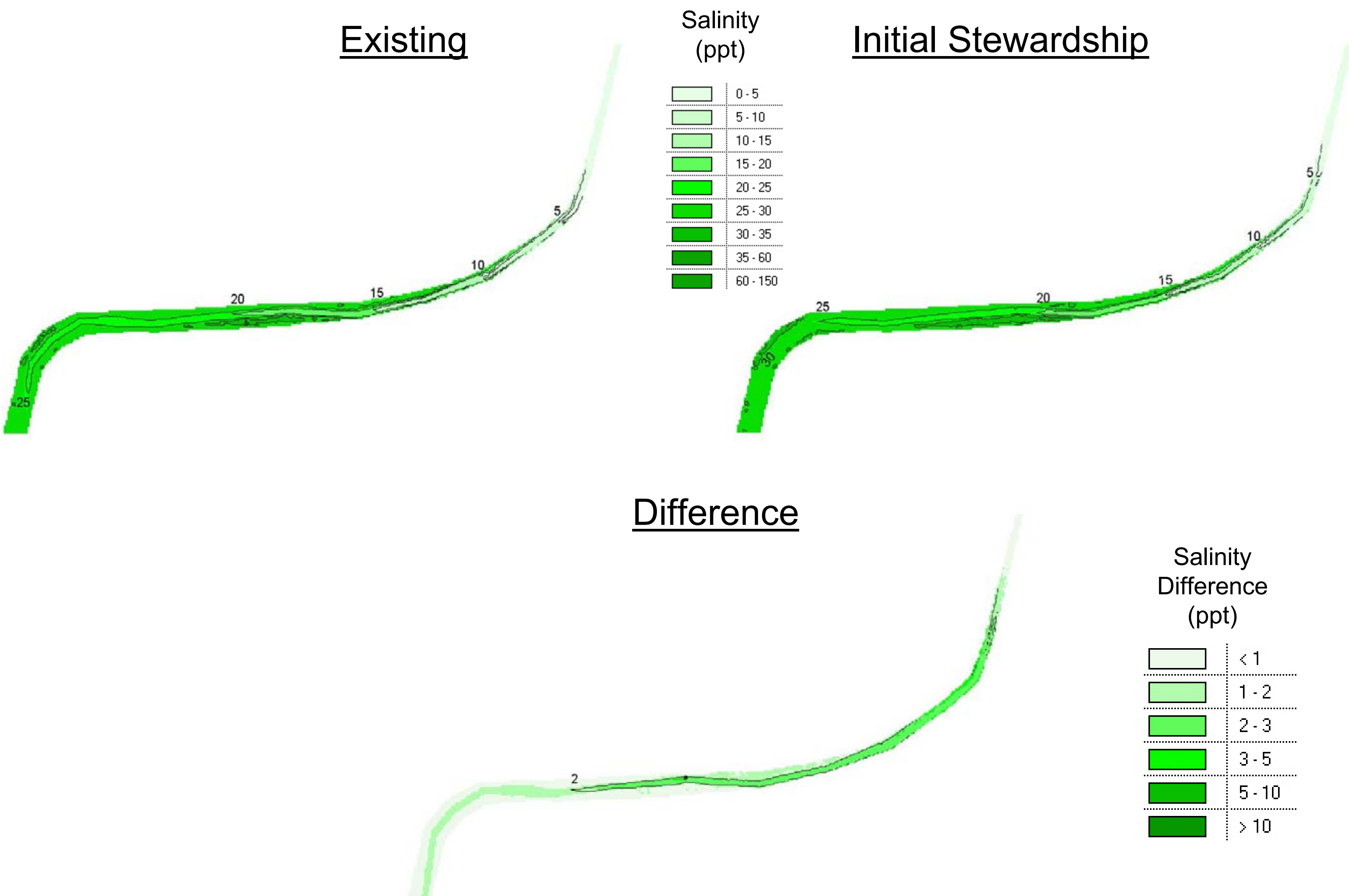


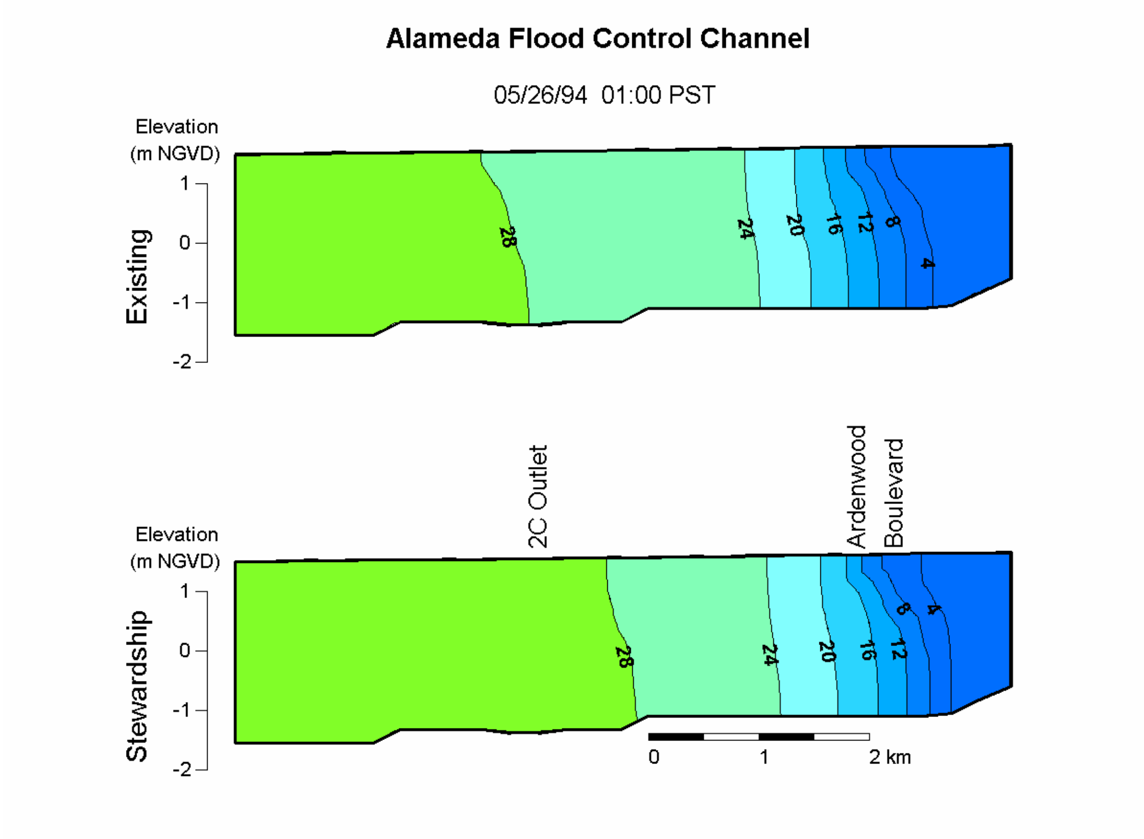
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 36. Predicted Salinity in the Alameda Flood Control Channel at the end of the Fifth Week of the Initial Release Period (Commencing April 1). Comparison of Longitudinal Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at 2002 Salinity Values".

Figure 37. Predicted Salinity in AFCC during **Initial Release Period** after 8 weeks of Discharge
((assumes Initial Release Commences **April1** at **2002 Salinity Values**)

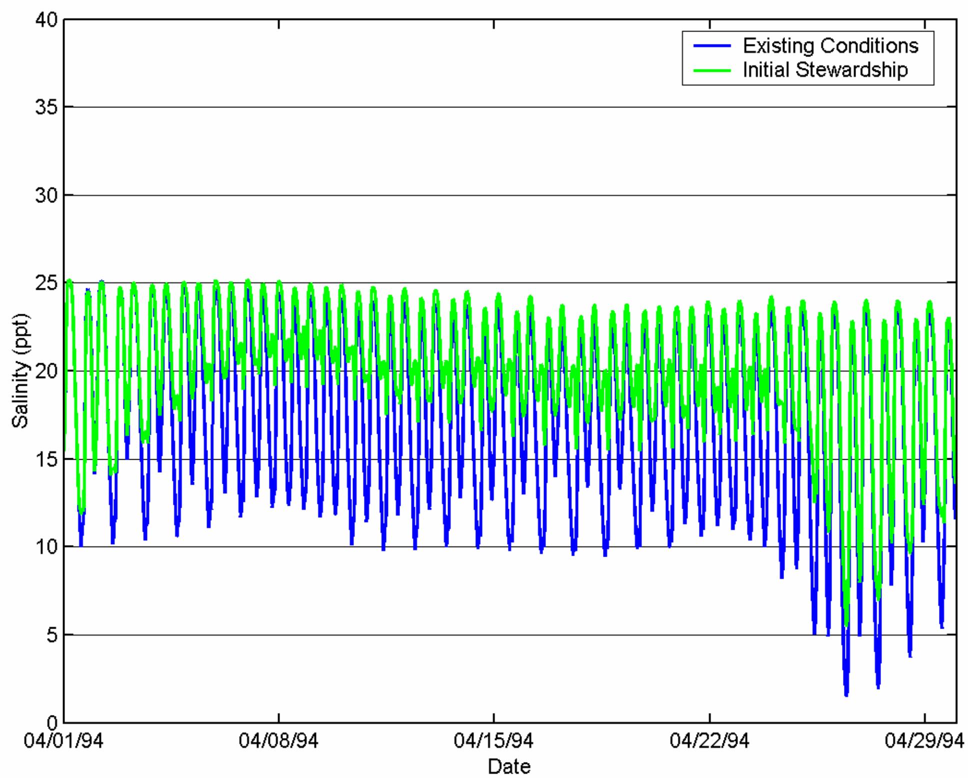
Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.





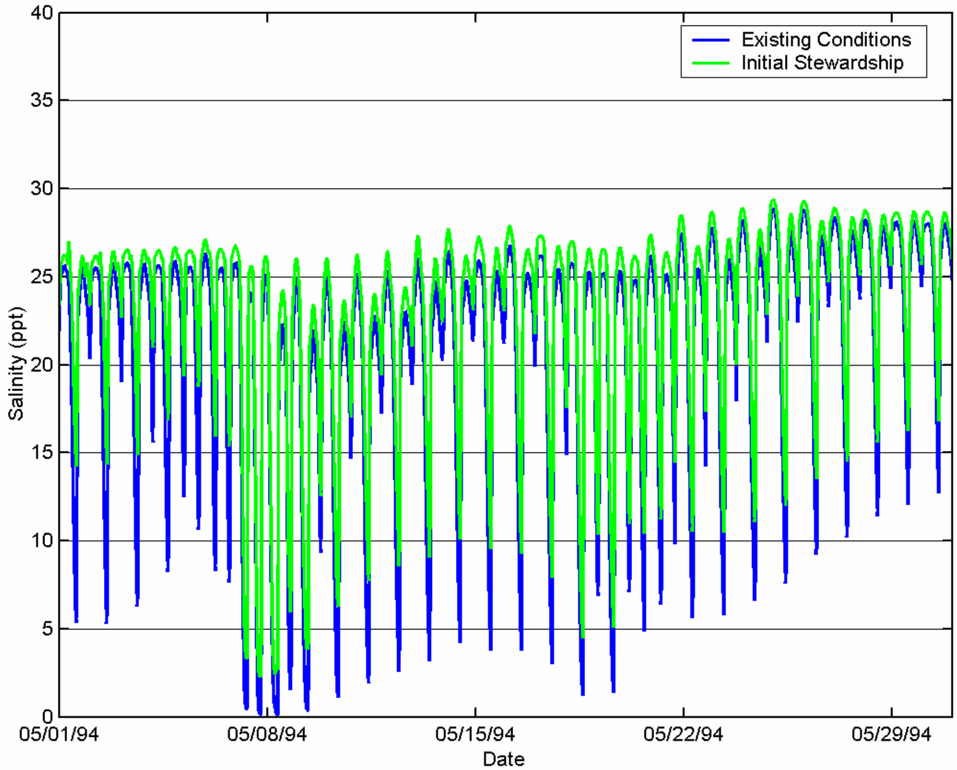
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 38. Predicted Salinity in the Alameda Flood Control Channel at the end of the Eighth Week of the Initial Release Period (Commencing April 1). Comparison of Longitudinal Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at 2002 Salinity Values".



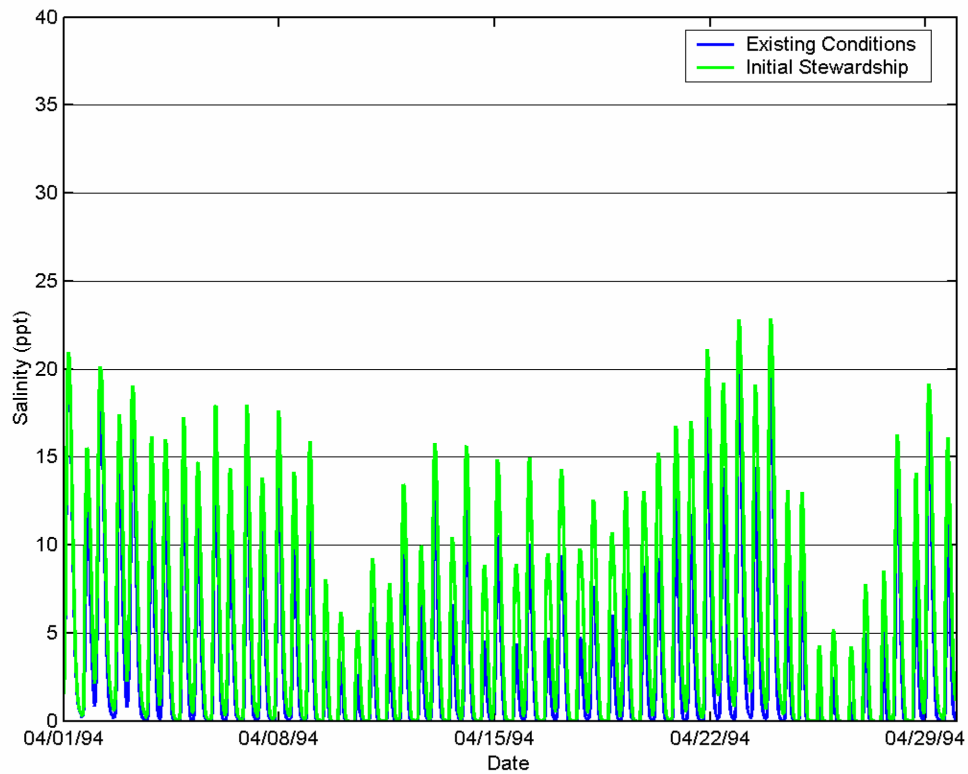
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 39. Predicted Salinity in the Alameda Flood Control Channel during the First Month of the Initial Release Period (Commencing April 1) at a Station 1 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at 2002 Salinity Values”.



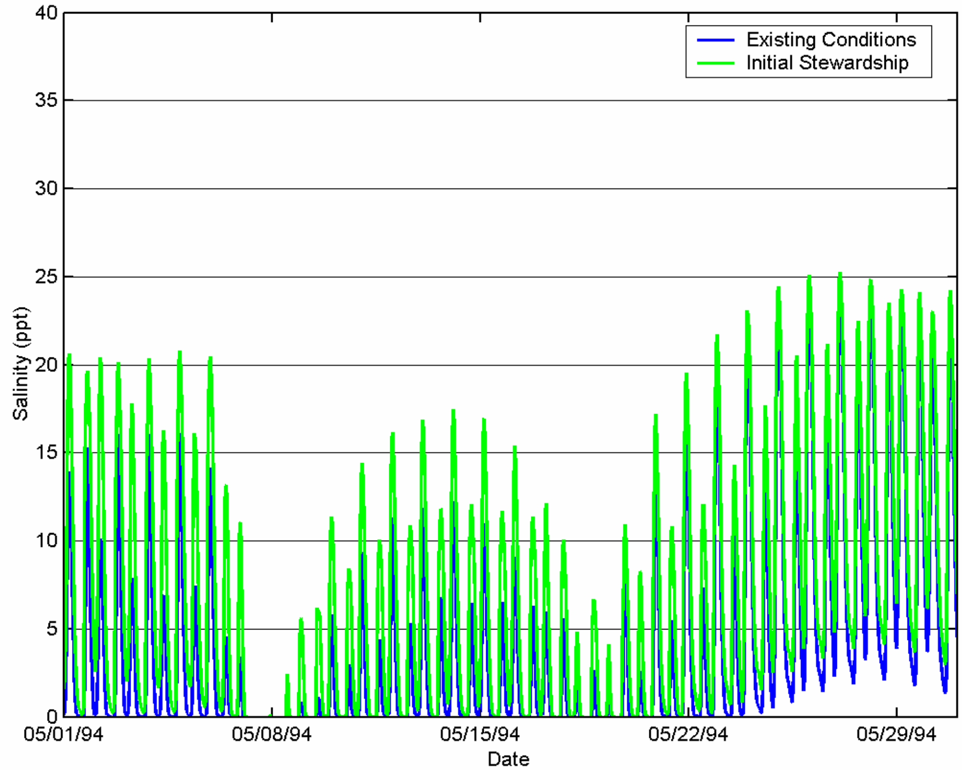
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 40. Predicted Salinity in the Alameda Flood Control Channel during the Second Month of the Initial Release Period (Commencing April 1) at a Station 1 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at 2002 Salinity Values".



Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 41. Predicted Salinity in the Alameda Flood Control Channel during the First Month of the Initial Release Period (Commencing April 1) at a Station 5 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at 2002 Salinity Values".

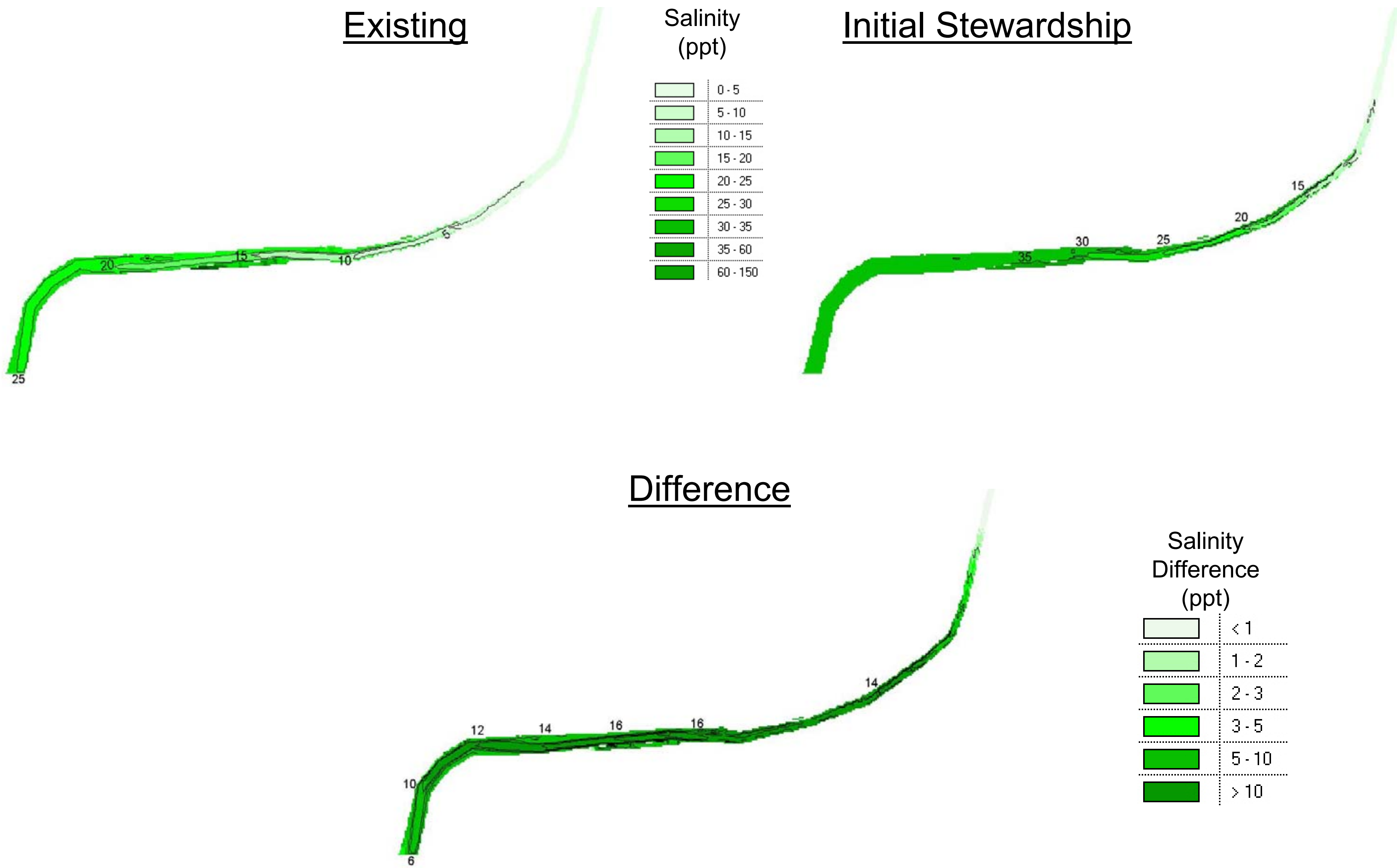


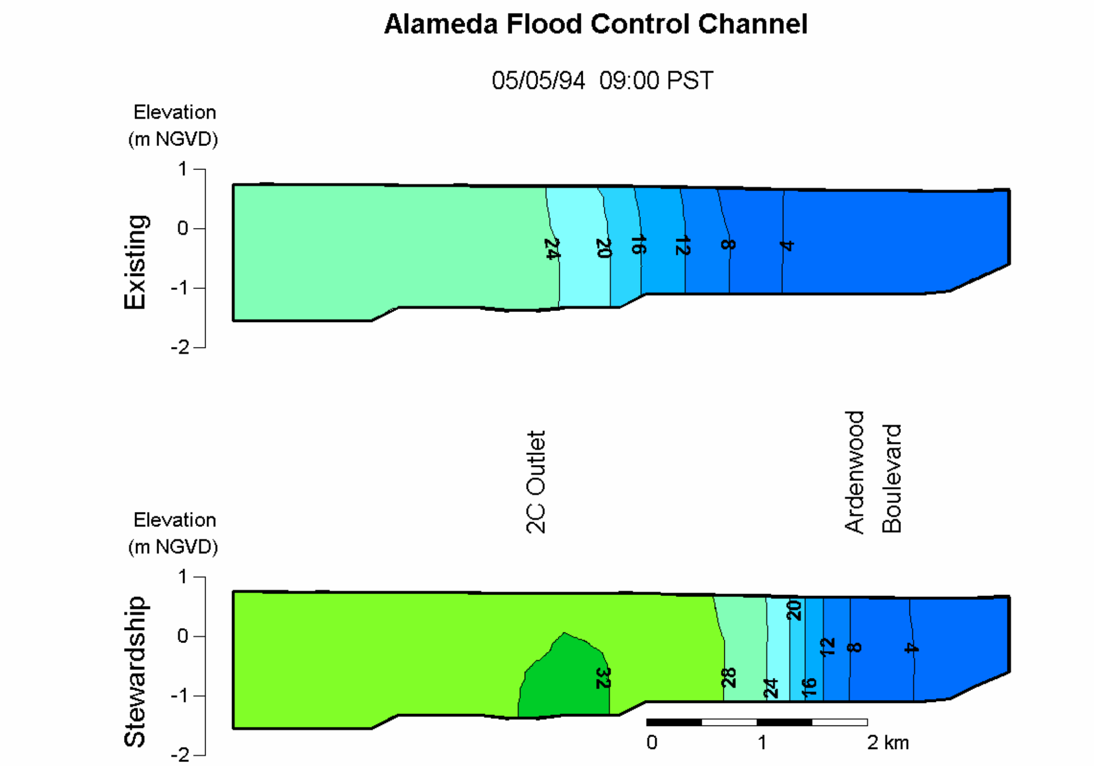
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 42. Predicted Salinity in the Alameda Flood Control Channel during the Second Month of the Initial Release Period (Commencing April 1) at a Station 5 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at 2002 Salinity Values".

Figure 43. Predicted Salinity in AFCC during **Initial Release Period** after **5 Weeks** of Discharge
(assumes Initial Release Commences **April 1** at **Proposed Maximum Salinity Values**)

Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.



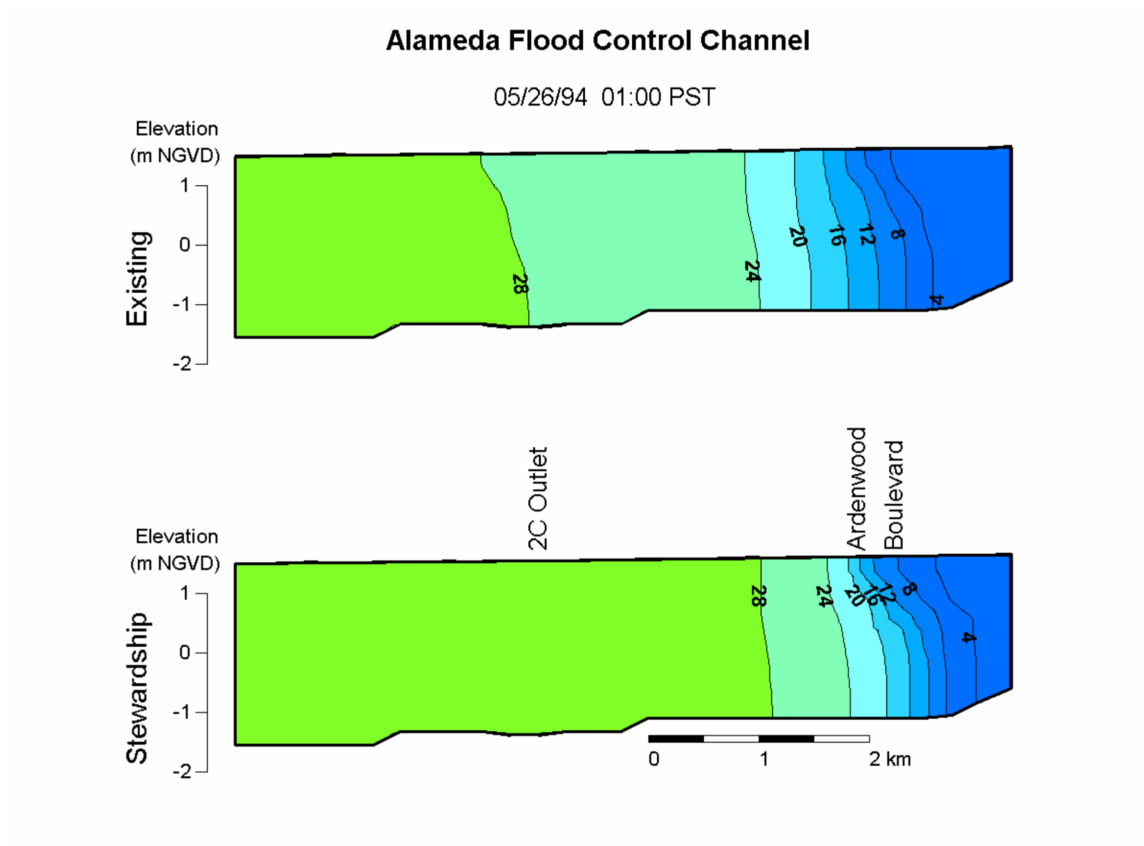


Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 44. Predicted Salinity in the Alameda Flood Control Channel at the end of the Fifth Week of the Initial Release Period (Commencing April 1). Comparison of Longitudinal Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".

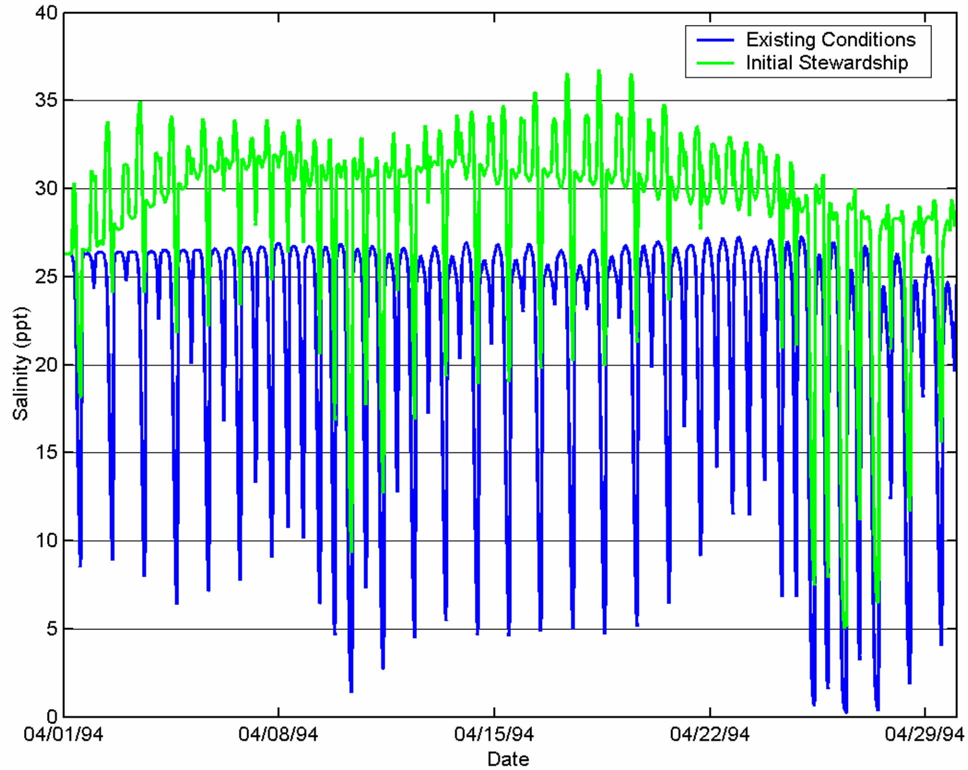
Figure 45. Predicted Salinity in AFCC during **Initial Release Period** after **8 Weeks** of Discharge
(assumes Initial Release Commences **April 1** at **Proposed Maximum Salinity Values**)

Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.



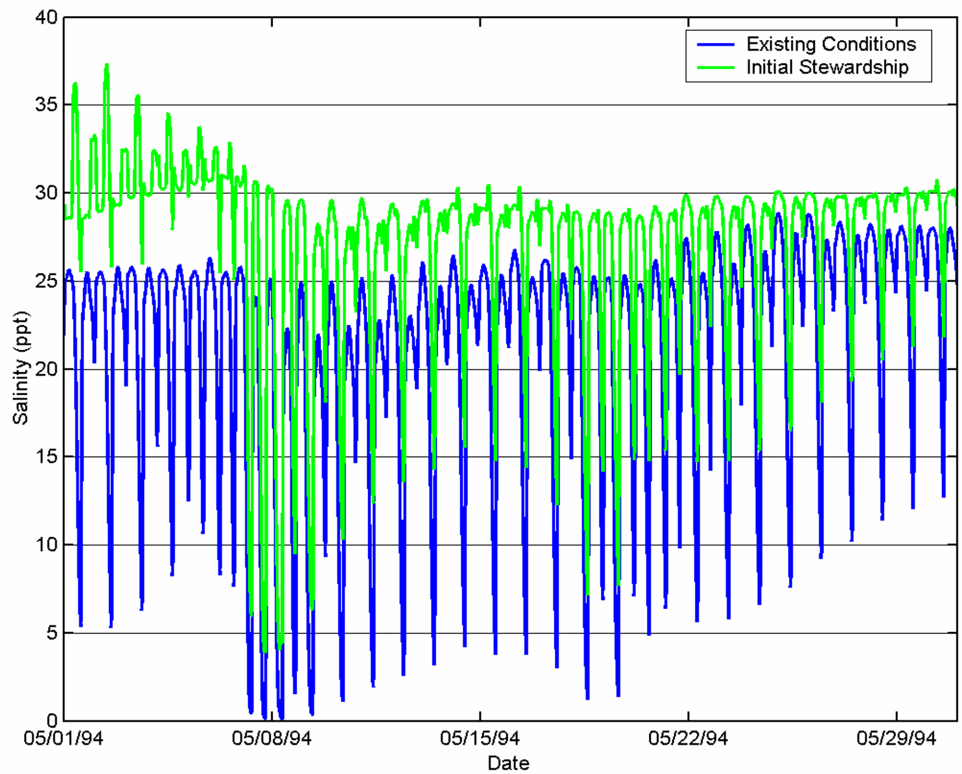
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 46. Predicted Salinity in the Alameda Flood Control Channel at the end of the Eighth Week of the Initial Release Period (Commencing April 1). Comparison of Longitudinal Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".



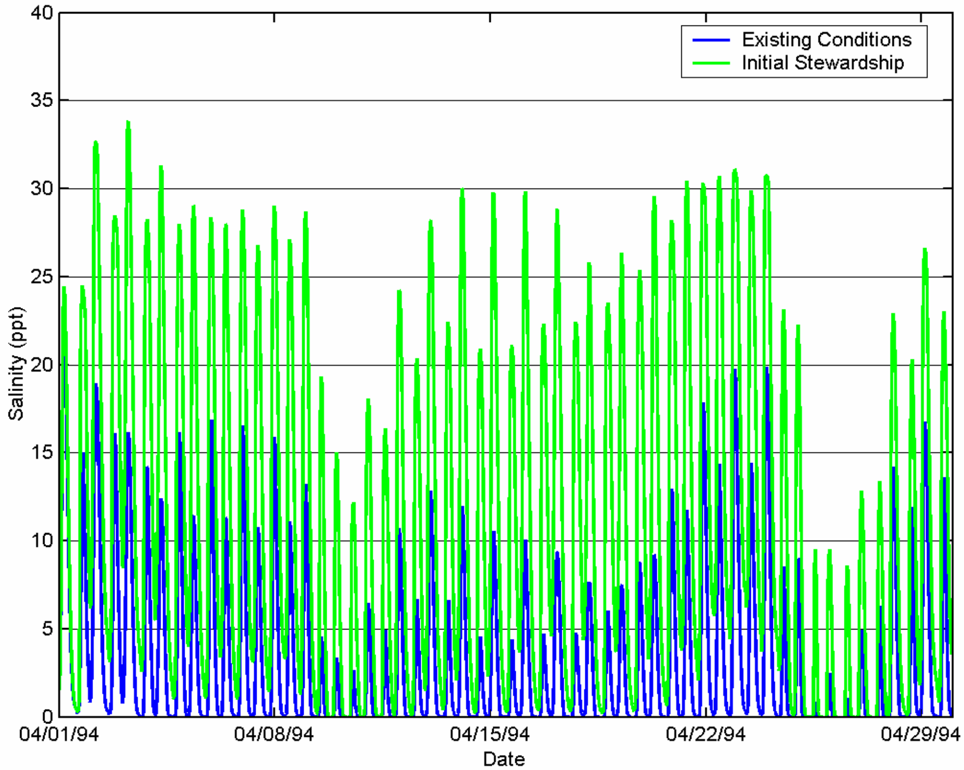
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 47. Predicted Salinity in the Alameda Flood Control Channel during the First Month of the Initial Release Period (Commencing April 1) at a Station 1 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".



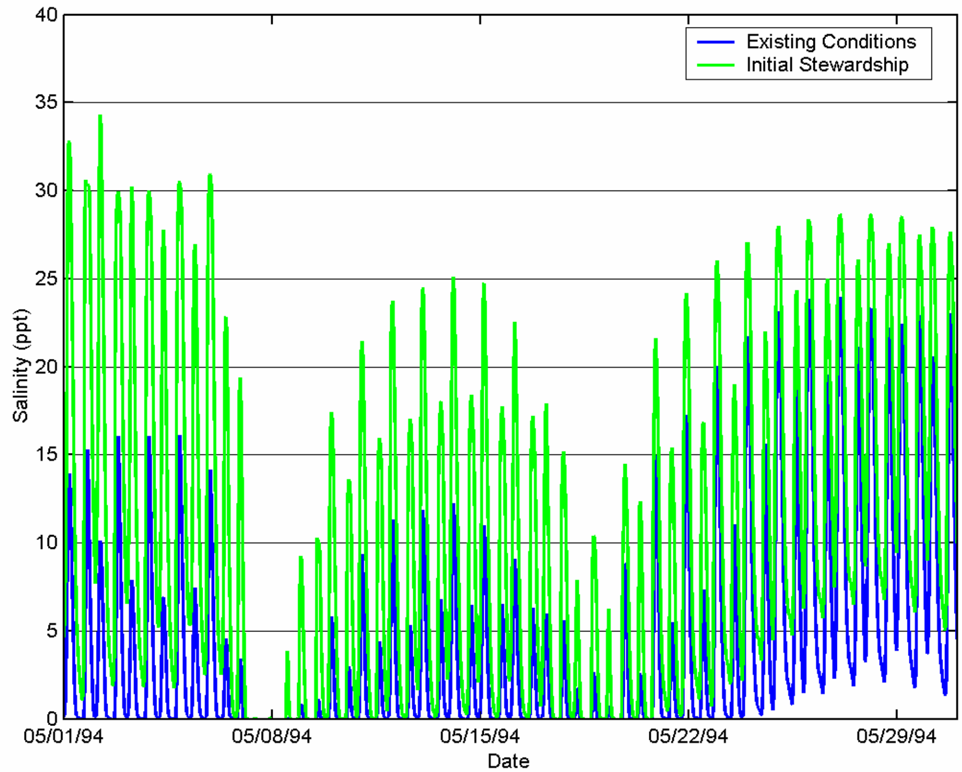
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 48. Predicted Salinity in the Alameda Flood Control Channel during the Second Month of the Initial Release Period (Commencing April 1) at a Station 1 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values”.



Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 49. Predicted Salinity in the Alameda Flood Control Channel during the First Month of the Initial Release Period (Commencing April 1) at a Station 5 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".

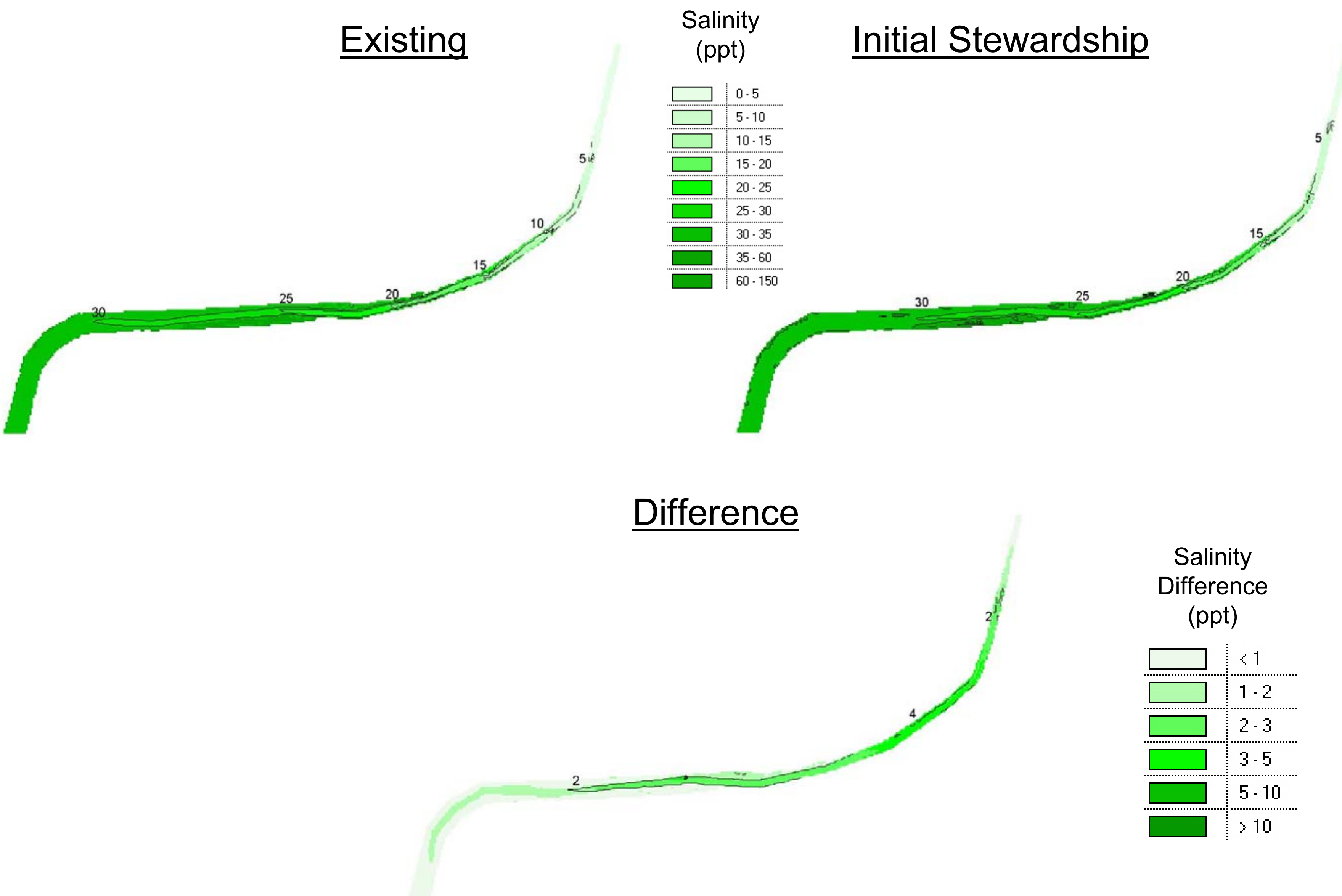


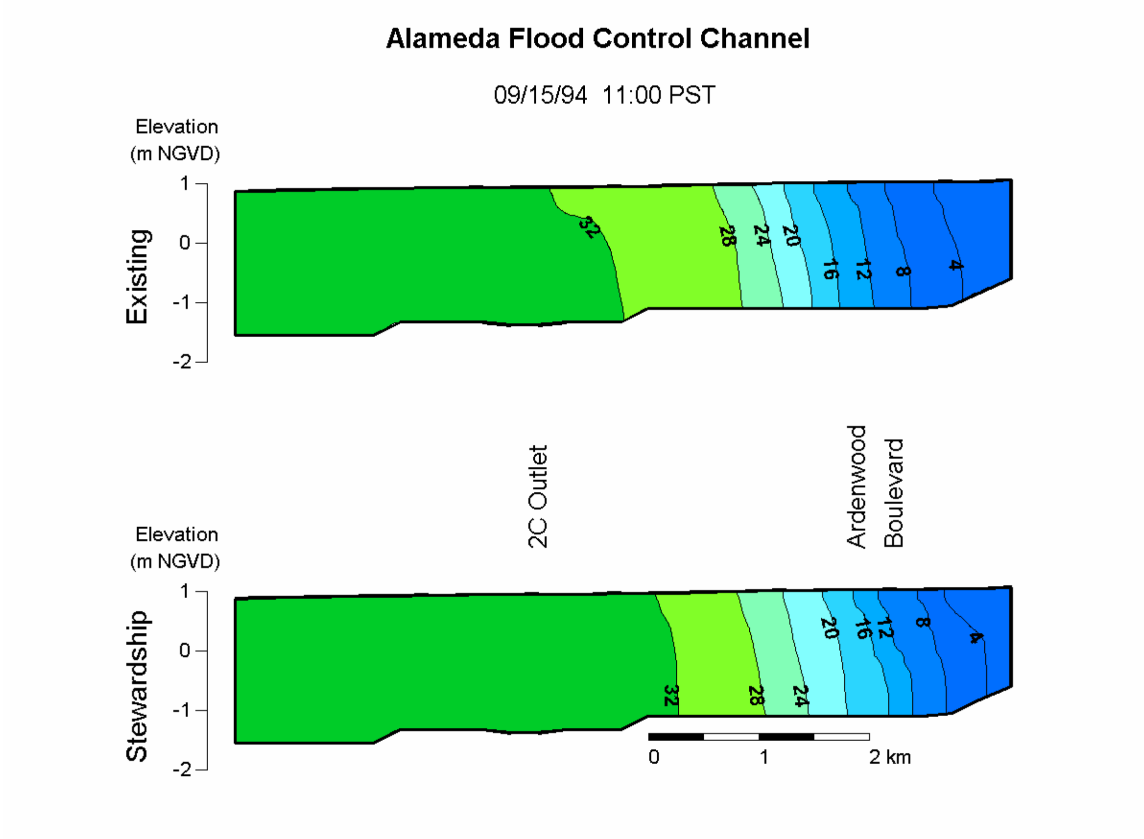
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 50. Predicted Salinity in the Alameda Flood Control Channel during the Second Month of the Initial Release Period (Commencing April 1) at a Station 5 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".

Figure 51. Predicted Salinity in AFCC during **Continuous Circulation Period** in **Late Summer**
(based on 9/15/94 conditions and assumes Initial Release has been completed)

Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.





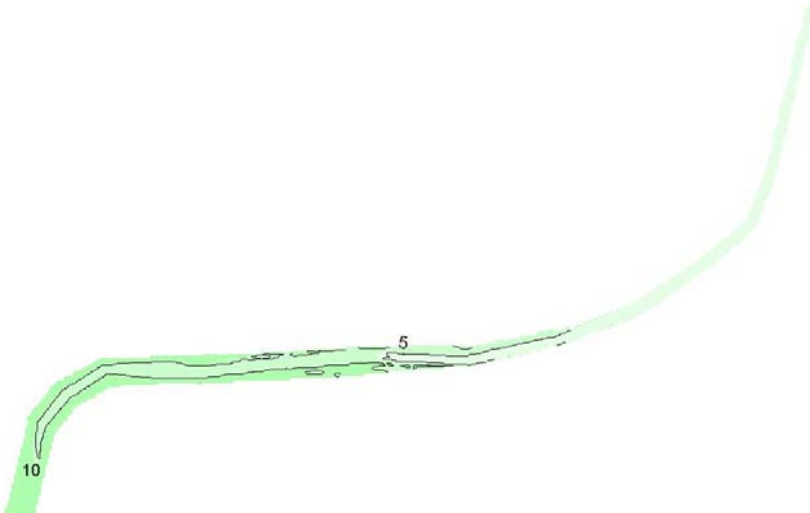
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 52. Predicted Salinity in the Alameda Flood Control Channel in mid-September during the Continuous Circulation Period. Comparison of Longitudinal Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Continuous Circulation Salinity Values".

Figure 53. Predicted Salinity in AFCC during **Continuous Circulation Period** in **Winter Storm Event**
(based on 2/20/95 conditions and assumes Initial Release has been completed)

Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.

Existing



Salinity (ppt)

	0 - 5
	5 - 10
	10 - 15
	15 - 20
	20 - 25
	25 - 30
	30 - 35
	35 - 60
	60 - 150

Initial Stewardship

Difference

Salinity Difference (ppt)

	< 1
	1 - 2
	2 - 3
	3 - 5
	5 - 10
	> 10

Figure 54. Predicted Salinity in AFCC during **Continuous Circulation Period** in **Winter Dry Period**
(based on 3/10/95 conditions and assumes Initial Release has been completed)

Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.

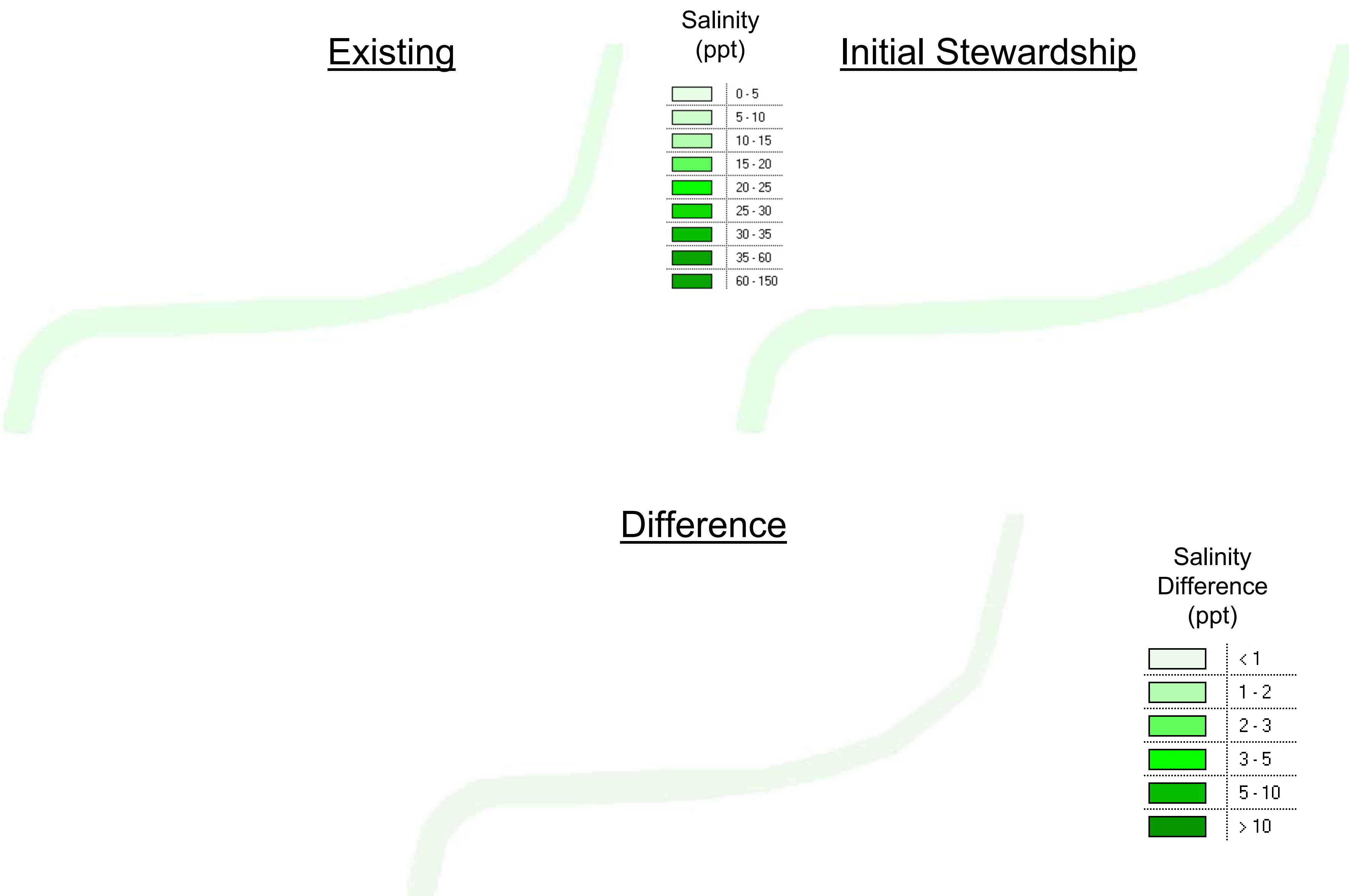


Figure 55. Predicted Salinity in AFCC during **Continuous Circulation Period** in **Late Spring**
(based on 6/1/95 conditions and assumes Initial Release has been completed)

Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.

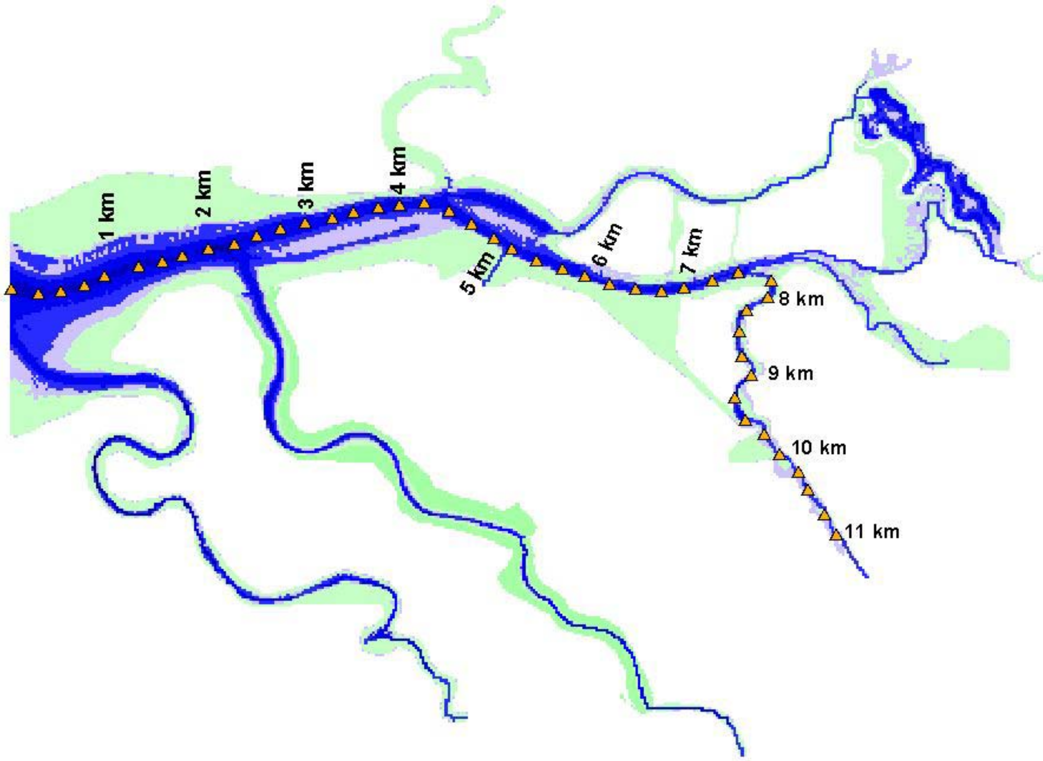
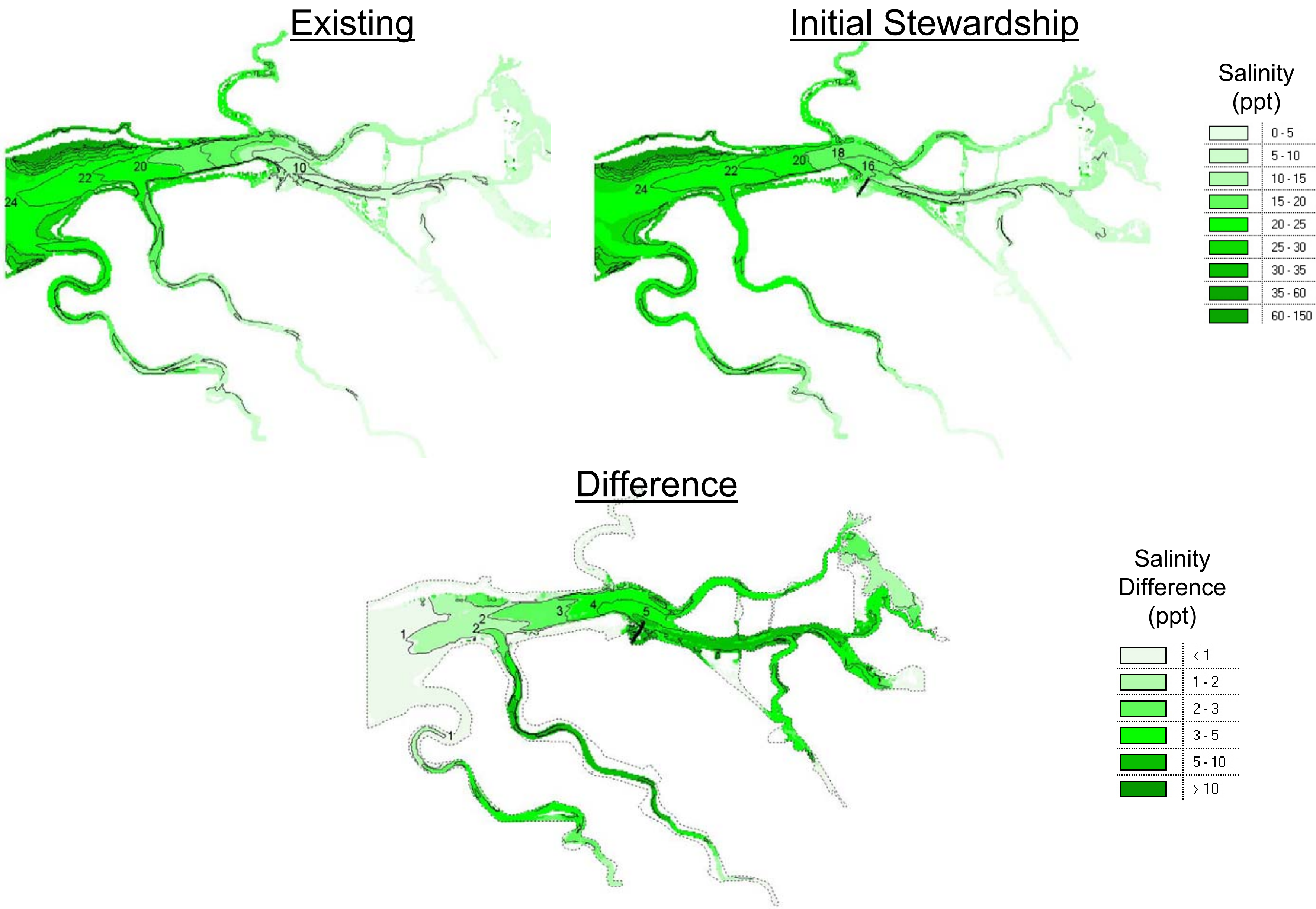
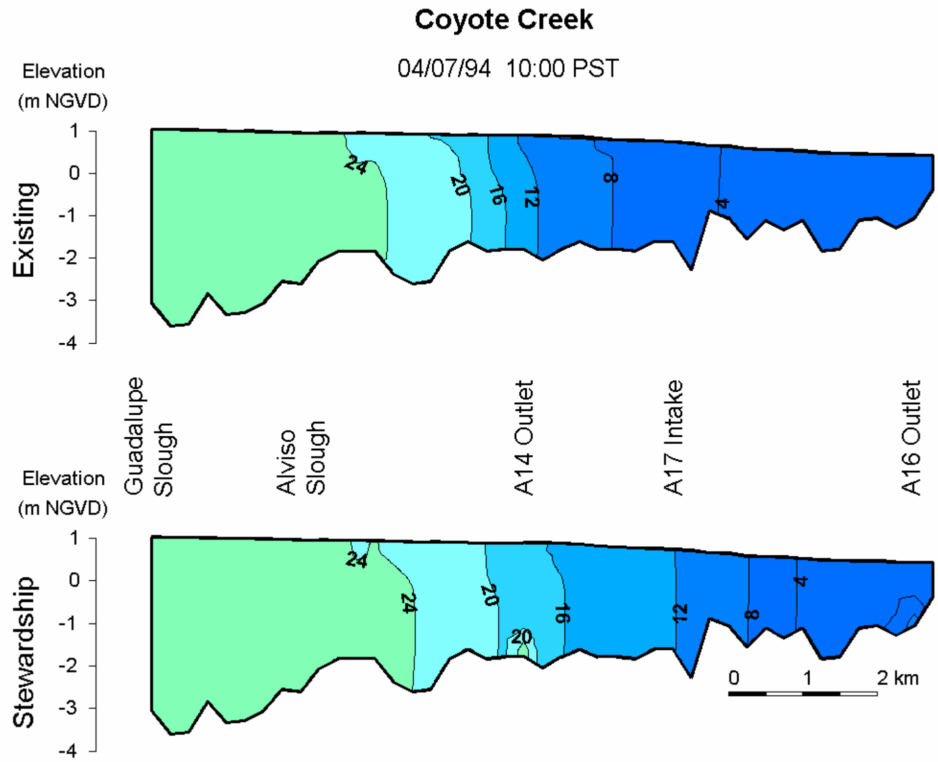


Figure 56. Distances along Coyote Creek and Artesian Slough – starting at the mouth of Coyote Creek and moving upstream.

Figure 57. Predicted Salinity in Coyote Creek during **Initial Release Period** after **1 Week** of Discharge
(assumes Initial Release Commences **April1** at **2002 Salinity Values**)

Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.



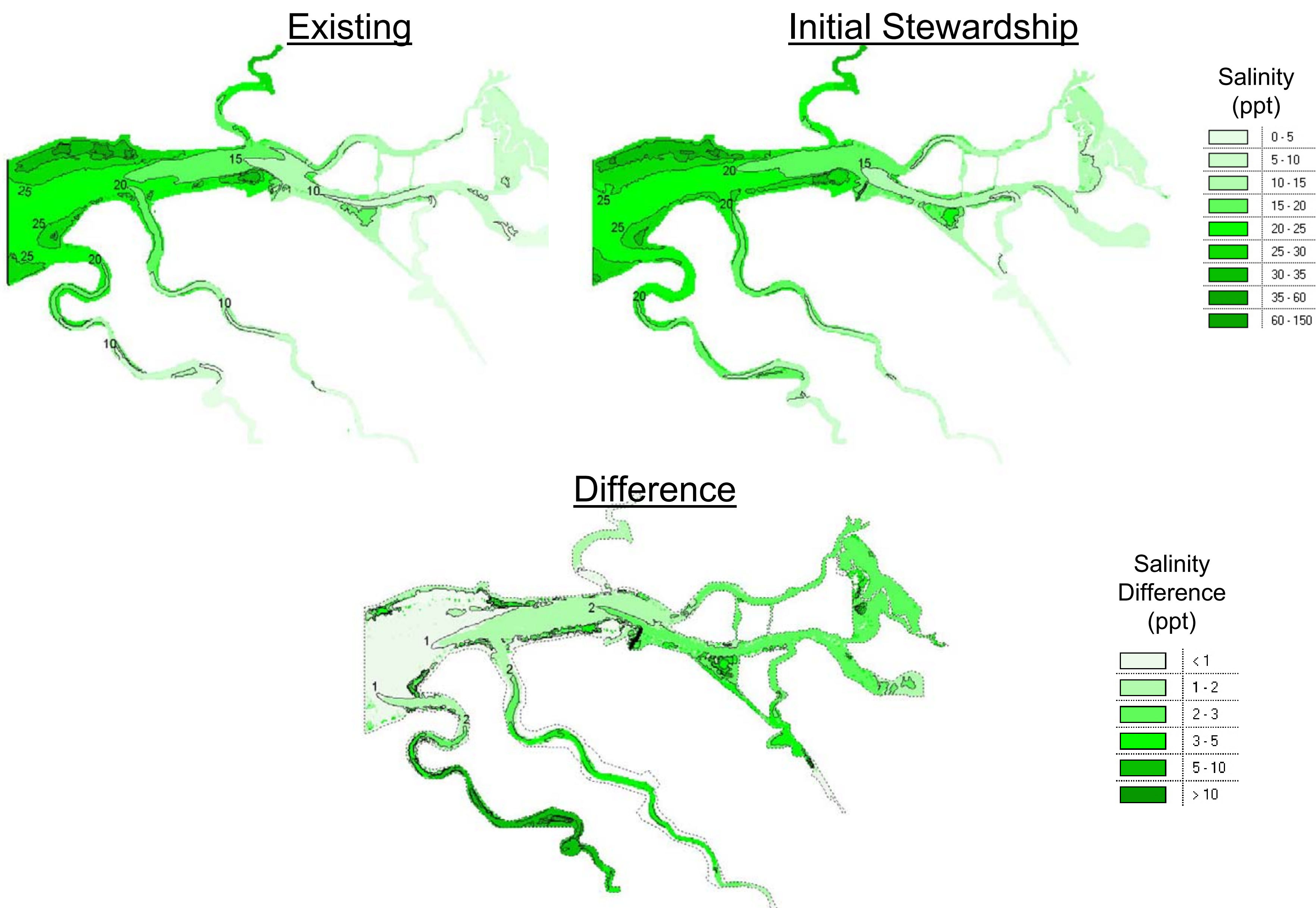


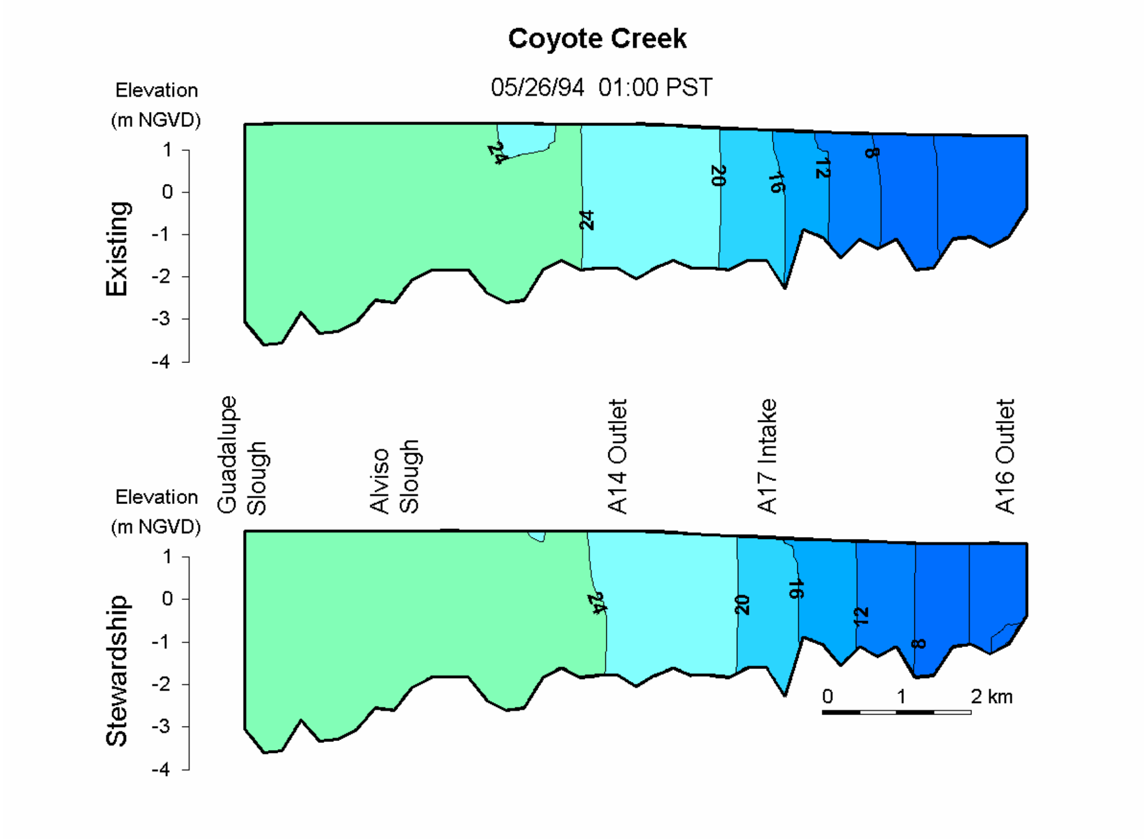
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 58. Predicted Salinity in Coyote Creek at the end of the First Week of the Initial Release Period (Commencing April 1). Comparison of Longitudinal Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at 2002 Salinity Values".

Figure 59. Predicted Salinity in Coyote Creek during **Initial Release Period** after **8 Weeks** of Discharge
(assumes Initial Release Commences **April1** at **2002 Salinity Values**)

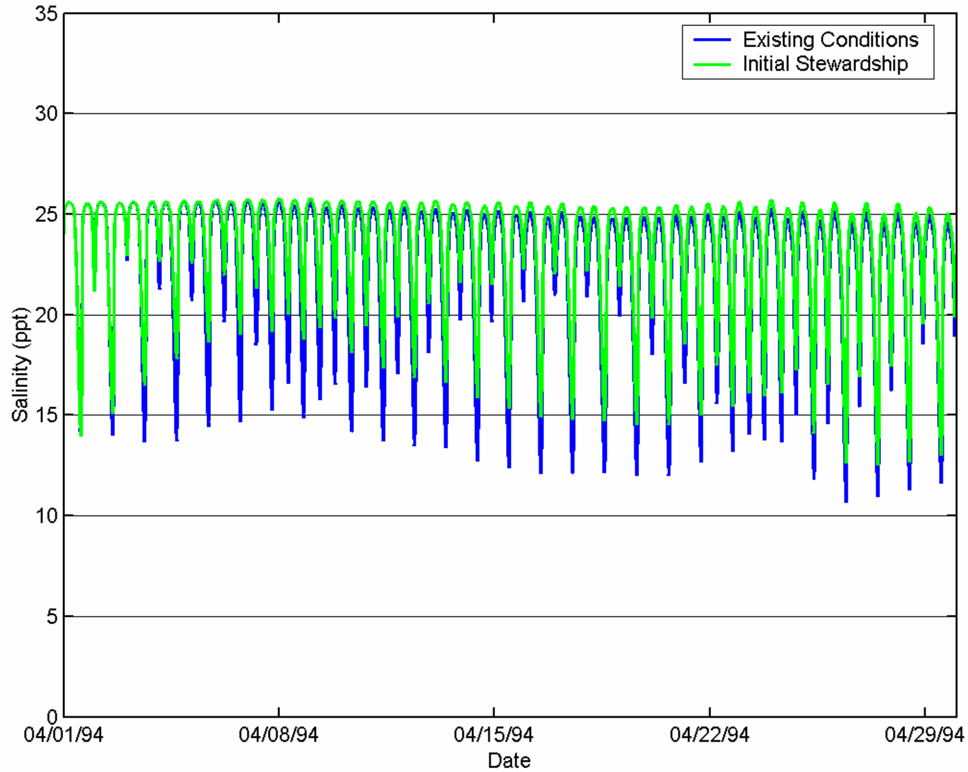
Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.





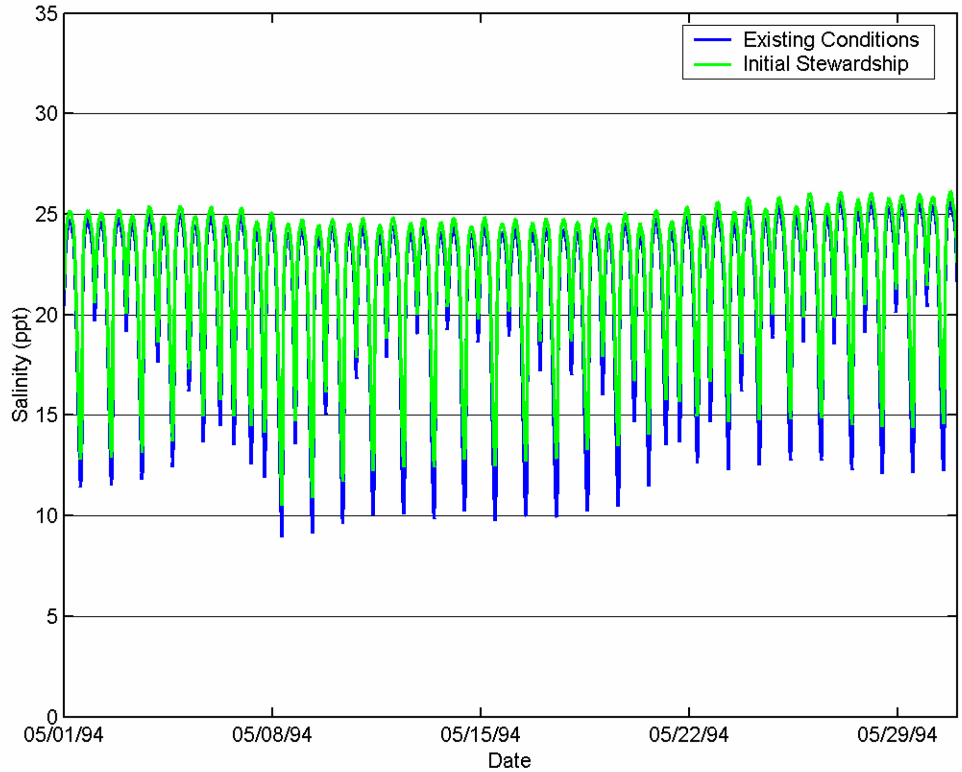
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 60. Predicted Salinity in Coyote Creek at the end of the Eighth Week of the Initial Release Period (Commencing April 1). Comparison of Longitudinal Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at 2002 Salinity Values".



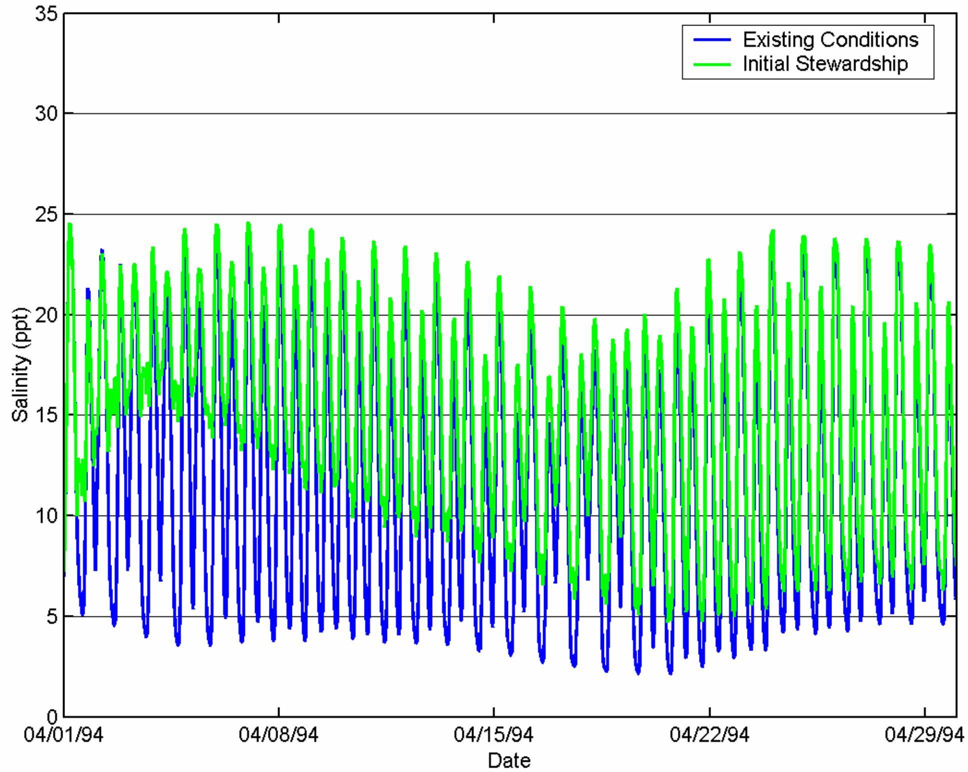
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 61. Predicted Salinity in Coyote Creek during the First Month of the Initial Release Period (Commencing April 1) at a Station 1 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at 2002 Salinity Values”.



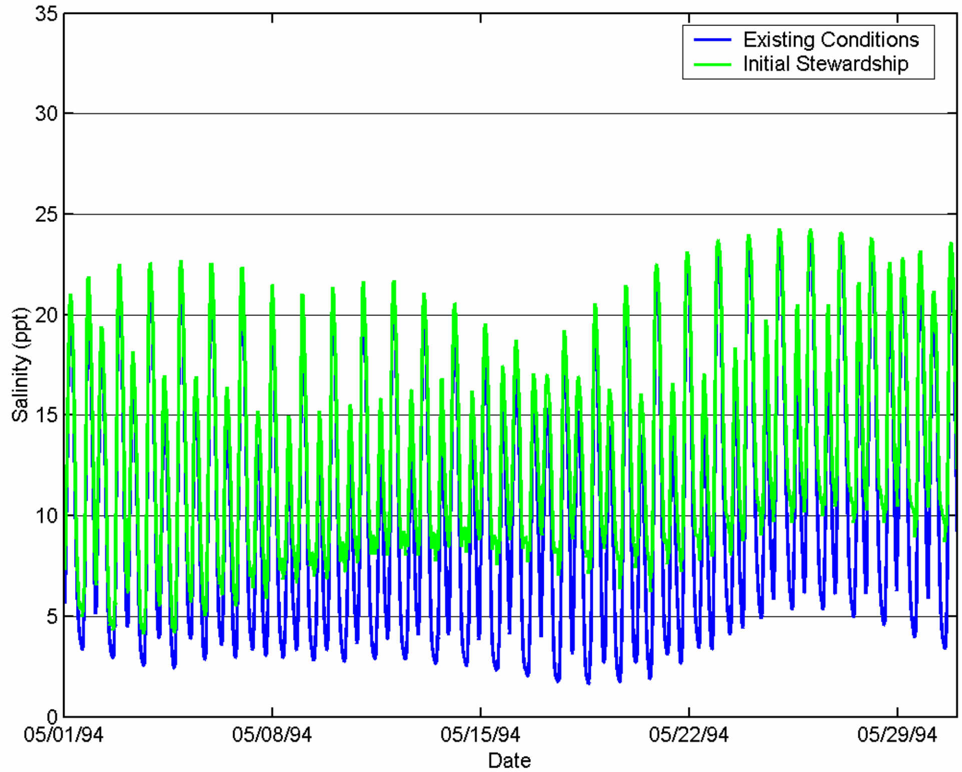
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 62. Predicted Salinity in Coyote Creek during the Second Month of the Initial Release Period (Commencing April 1) at a Station 1 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at 2002 Salinity Values”.



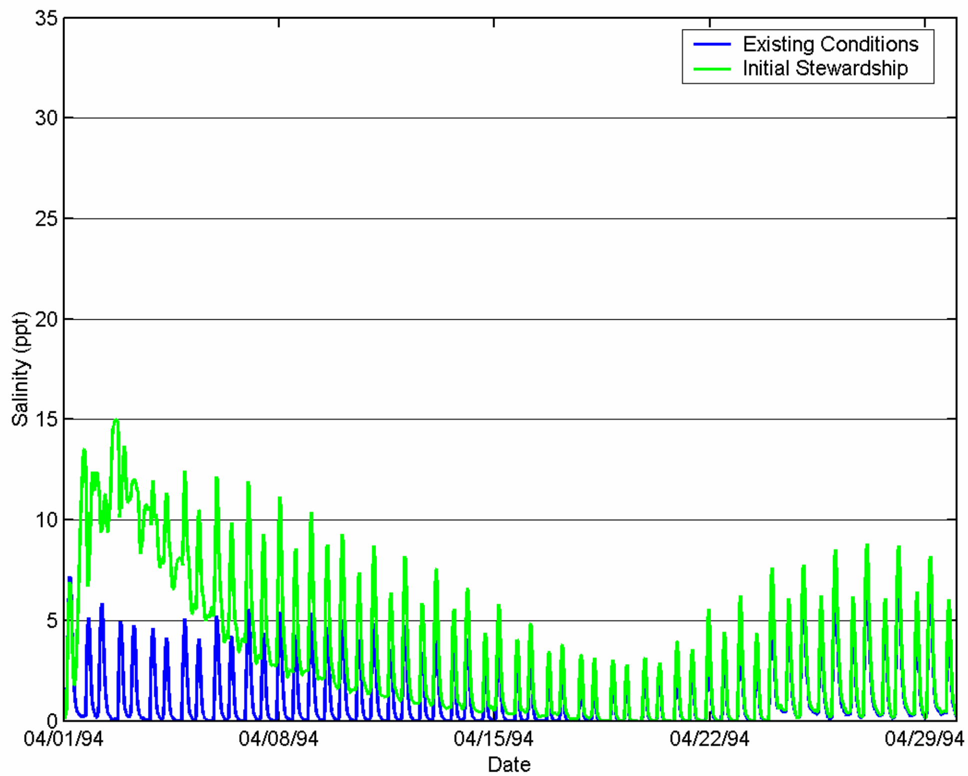
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 63. Predicted Salinity in Coyote Creek during the First Month of the Initial Release Period (Commencing April 1) at a Station 5 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at 2002 Salinity Values".



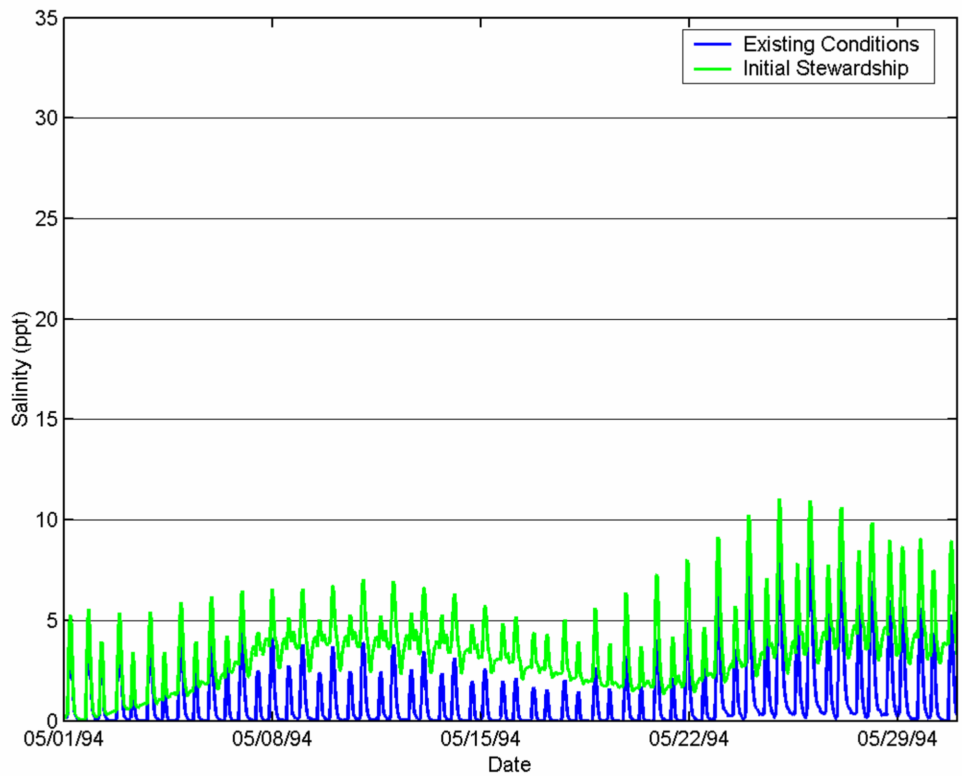
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 64. Predicted Salinity in Coyote Creek during the Second Month of the Initial Release Period (Commencing April 1) at a Station 5 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at 2002 Salinity Values".



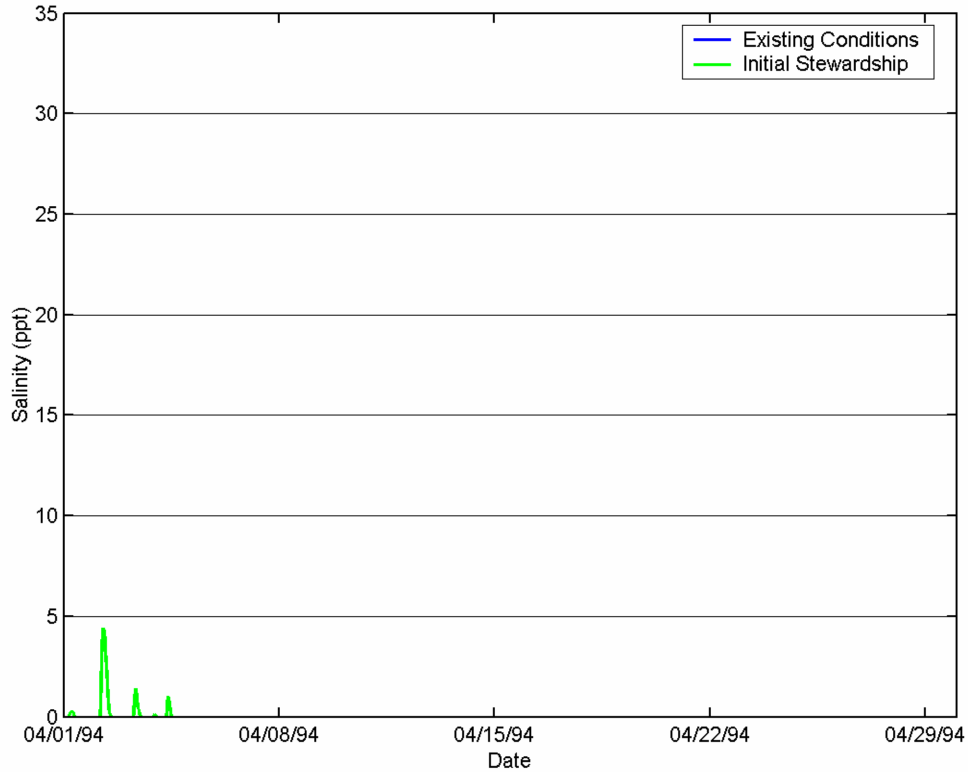
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 65. Predicted Salinity in Coyote Creek during the First Month of the Initial Release Period (Commencing April 1) at a Station 9 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at 2002 Salinity Values".



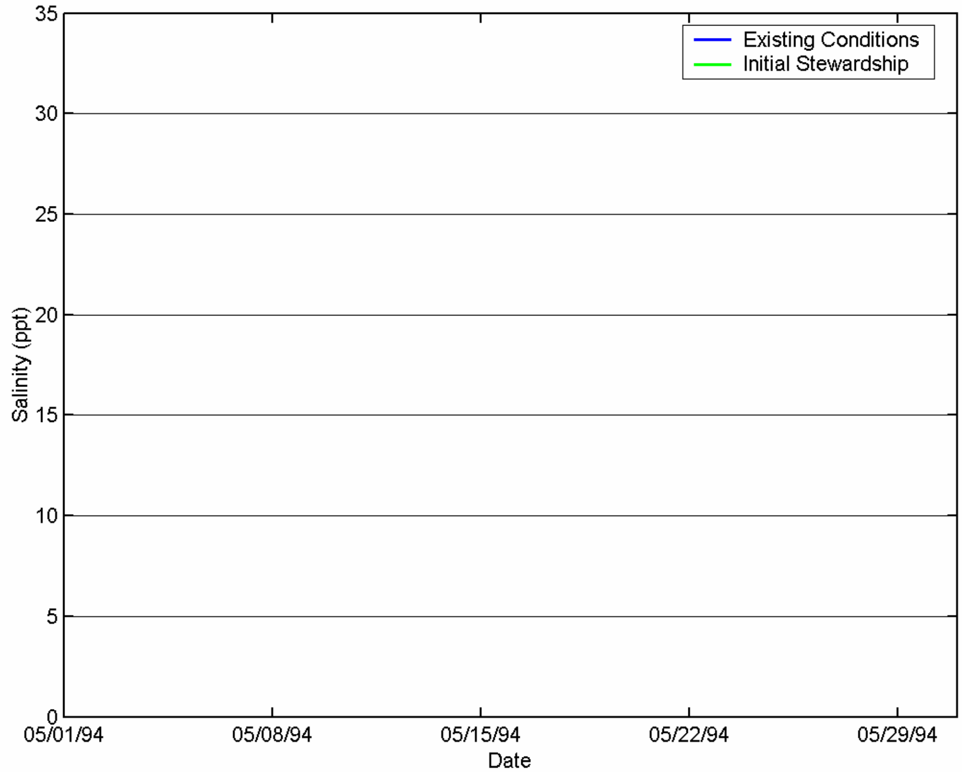
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 66. Predicted Salinity in Coyote Creek during the Second Month of the Initial Release Period (Commencing April 1) at a Station 9 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at 2002 Salinity Values”.



Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 67. Predicted Salinity in Coyote Creek during the First Month of the Initial Release Period (Commencing April 1) at a Station 11 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at 2002 Salinity Values”.

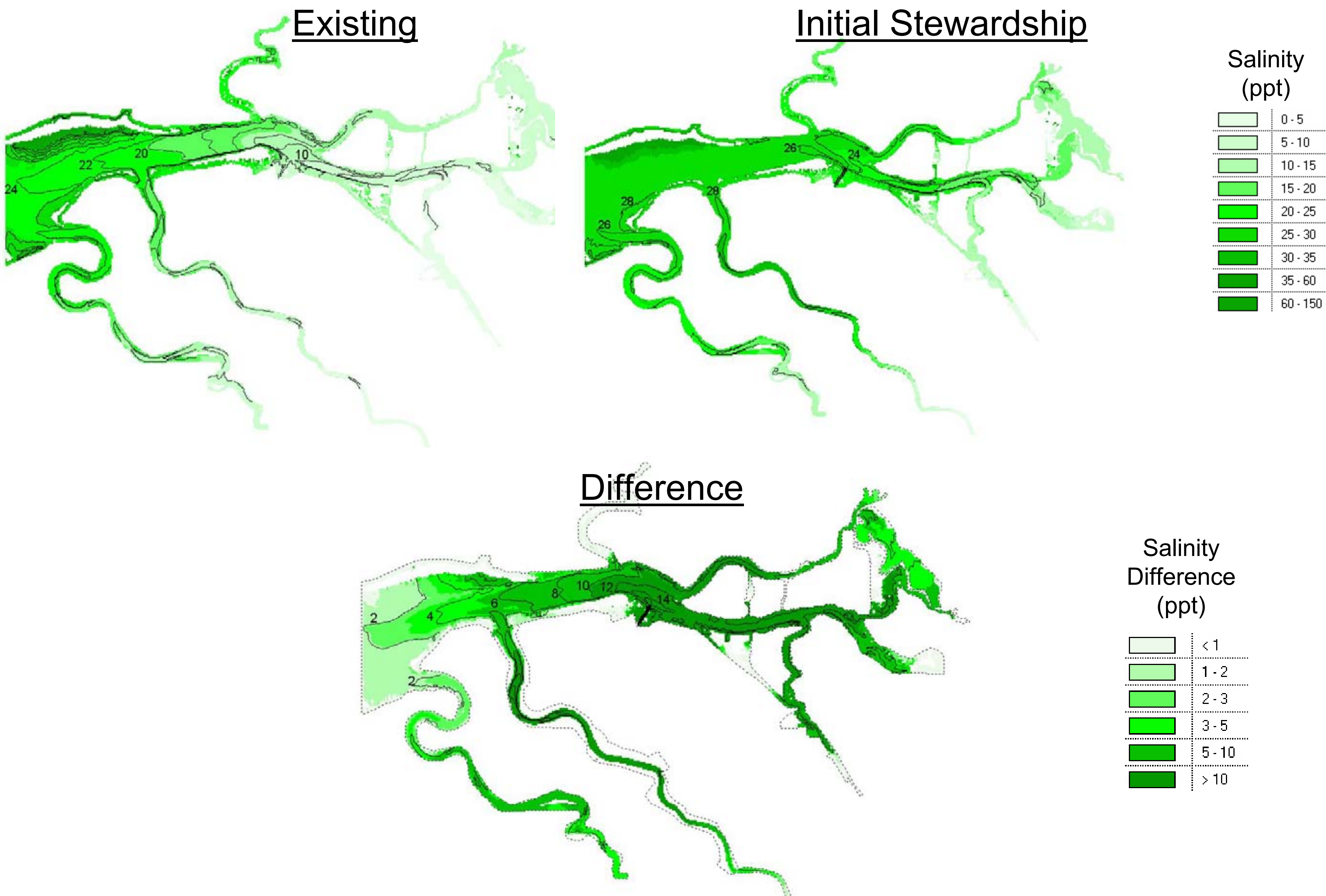


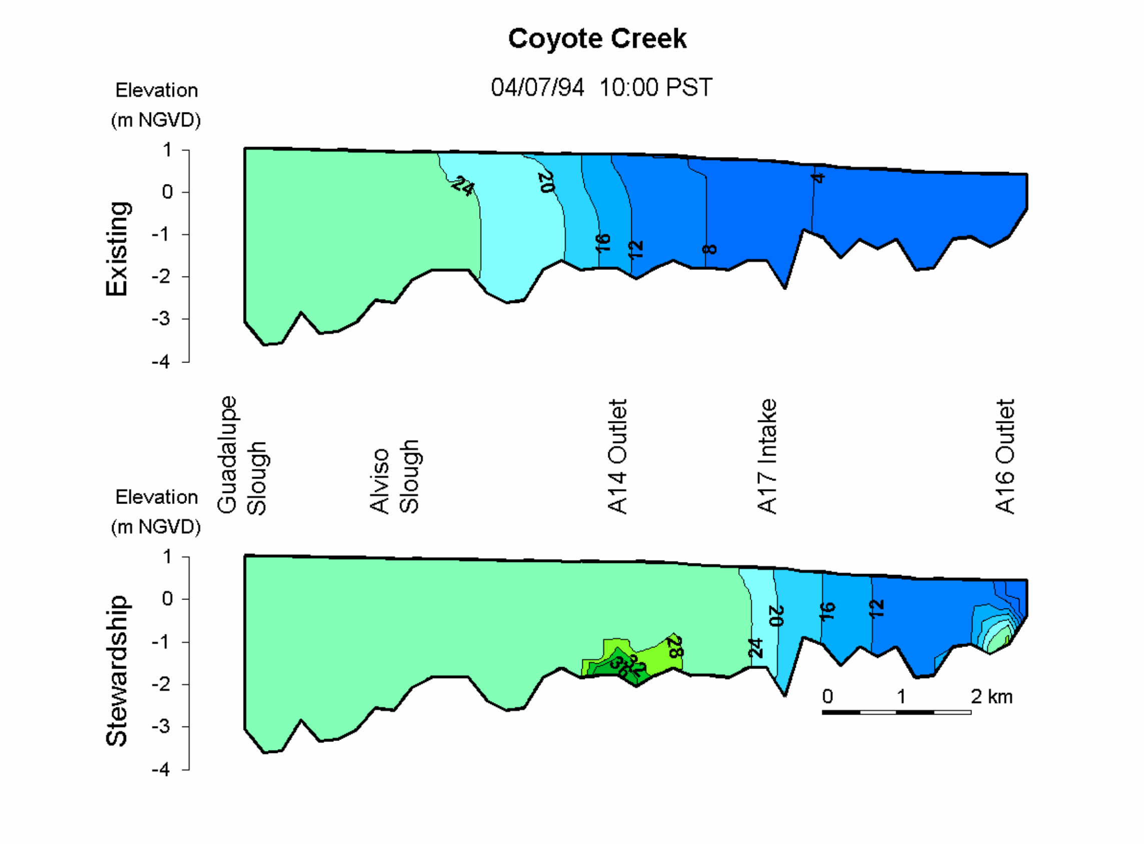
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 68. Predicted Salinity in Coyote Creek during the Second Month of the Initial Release Period (Commencing April 1) at a Station 11 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at 2002 Salinity Values".

Figure 69. Predicted Salinity in Coyote Creek during **Initial Release Period** after **1 Week** of Discharge
(assumes Initial Release Commences **April1** at **Proposed Maximum Salinity Values**)

Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.



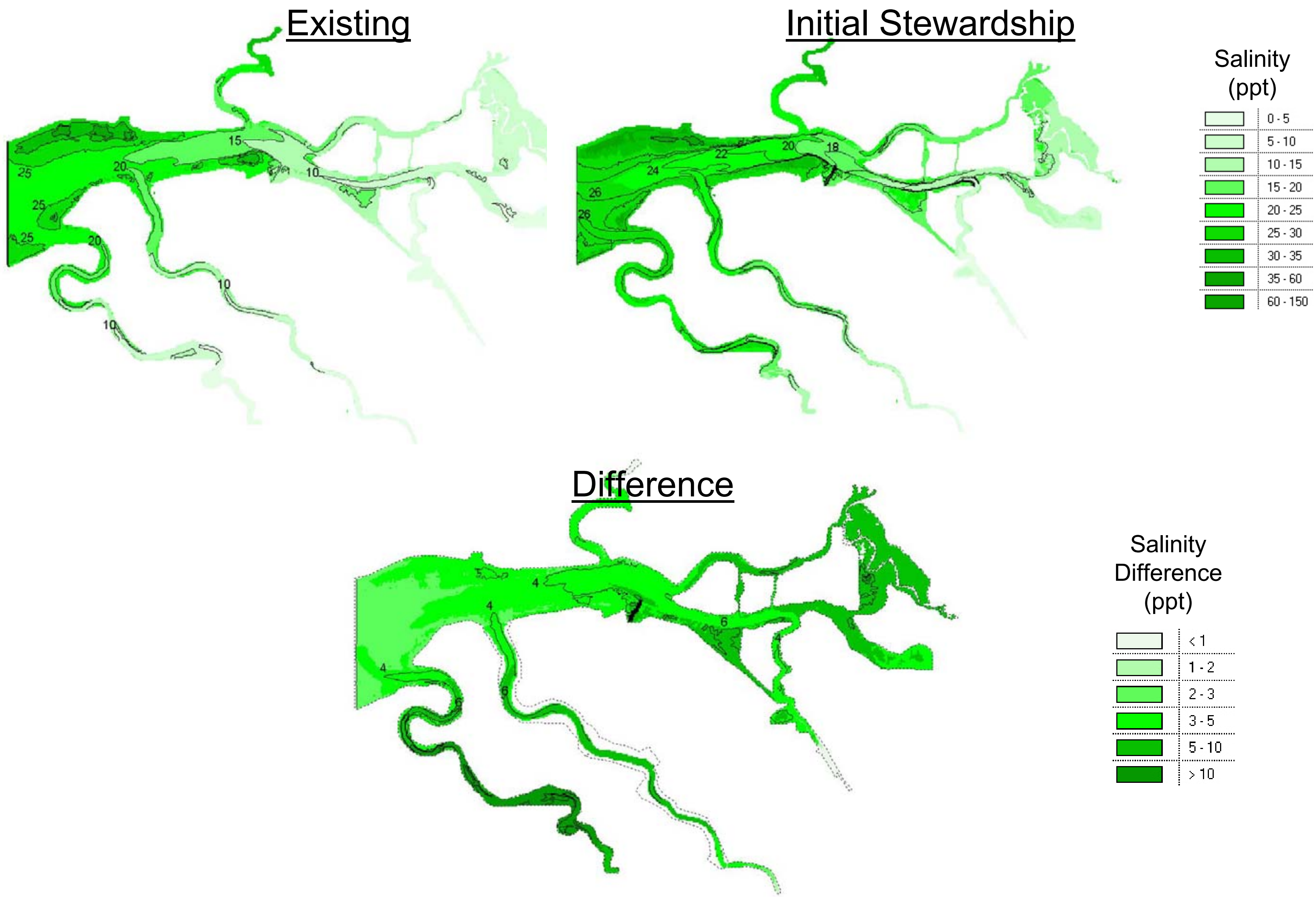


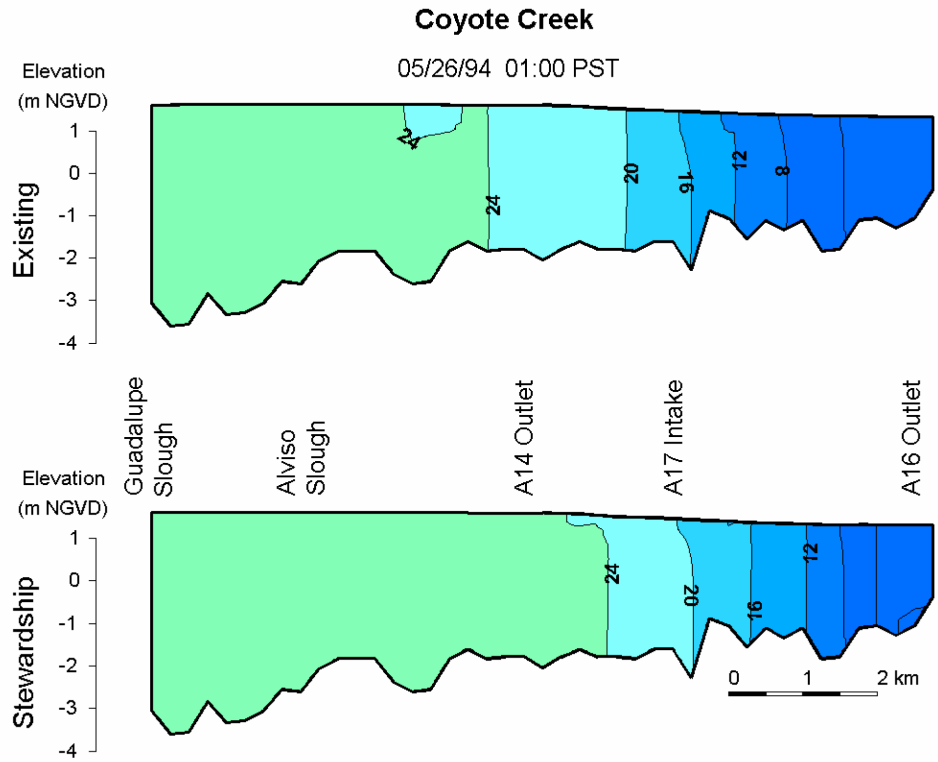
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 70. Predicted Salinity in Coyote Creek at the end of the First Week of the Initial Release Period (Commencing April 1). Comparison of Longitudinal Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".

Figure 71. Predicted Salinity in Coyote Creek during **Initial Release Period** after **8 Weeks** of Discharge
(assumes Initial Release Commences **April1** at **Proposed Maximum Salinity Values**)

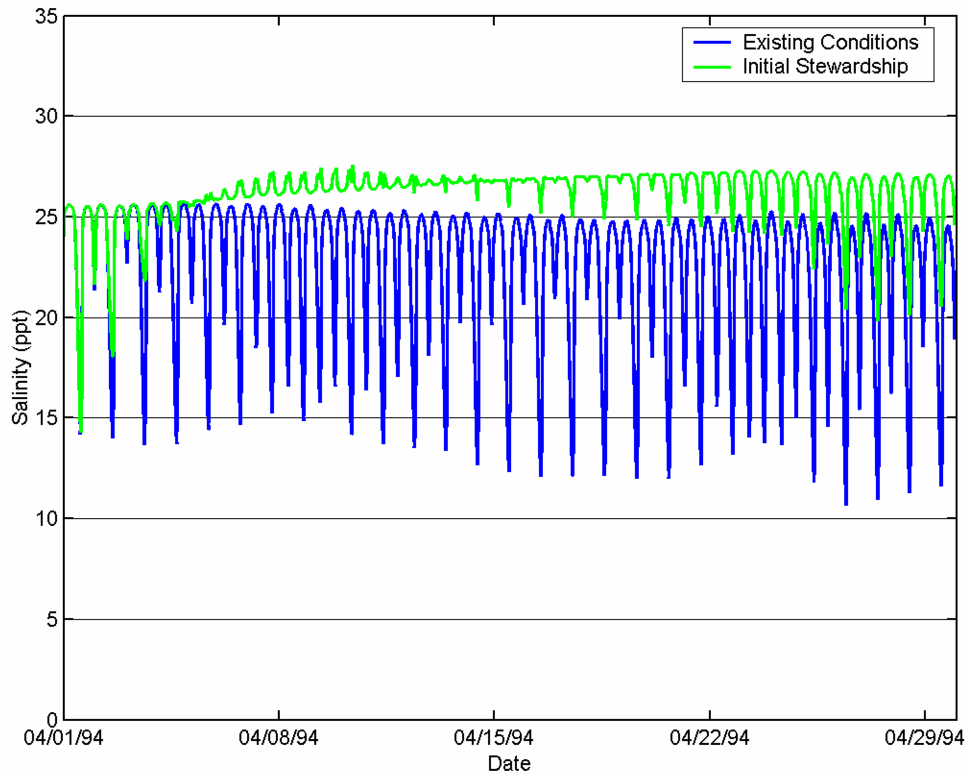
Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.





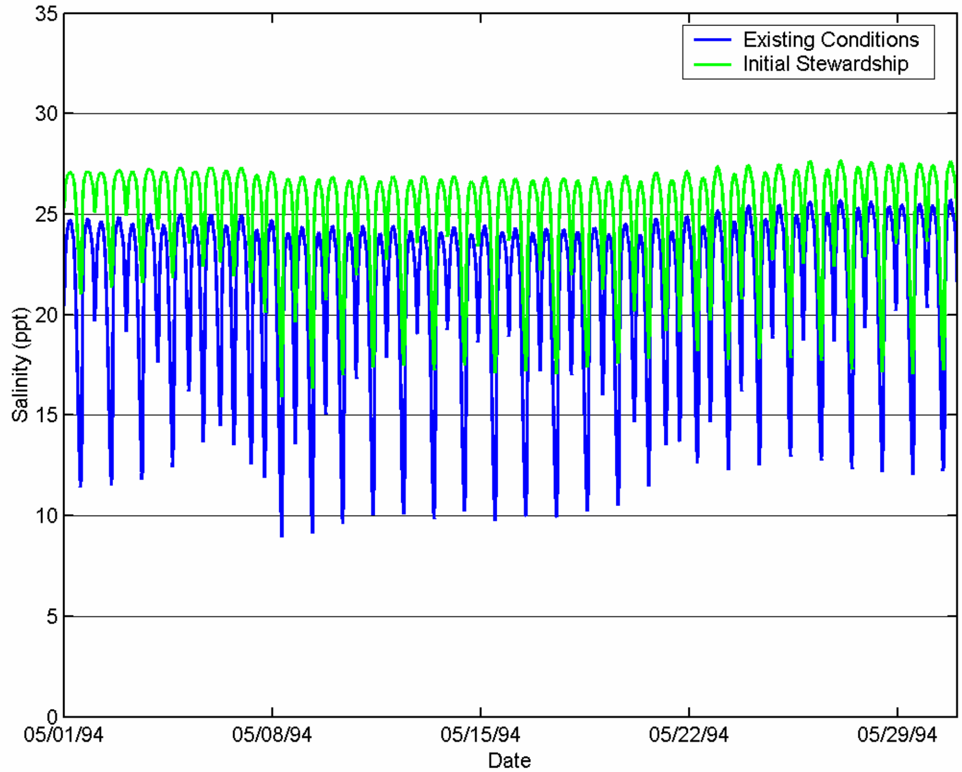
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 72. Predicted Salinity in Coyote Creek at the end of the Eighth Week of the Initial Release Period (Commencing April 1). Comparison of Longitudinal Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".



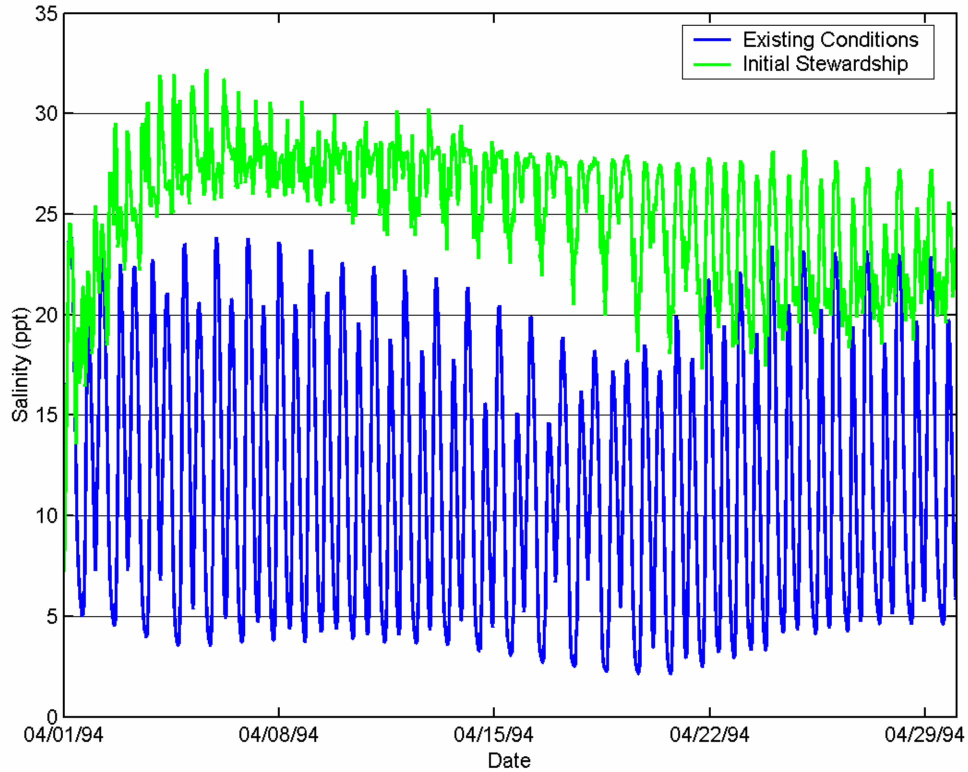
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 73. Predicted Salinity in Coyote Creek during the First Month of the Initial Release Period (Commencing April 1) at a Station 1 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".



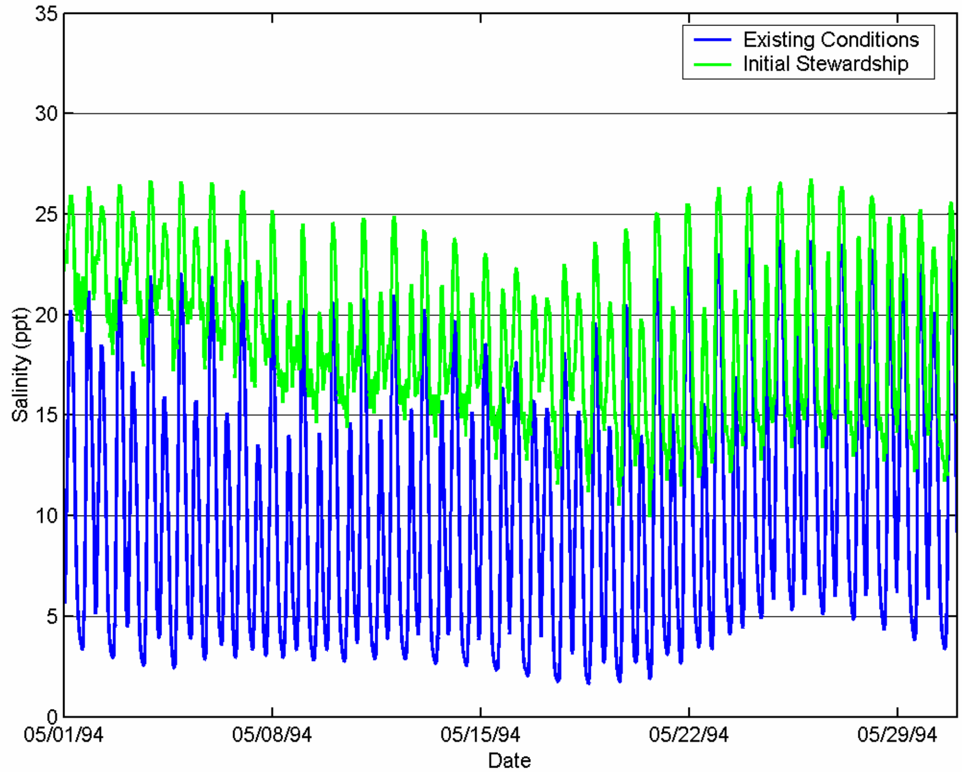
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 74. Predicted Salinity in Coyote Creek during the Second Month of the Initial Release Period (Commencing April 1) at a Station 1 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".



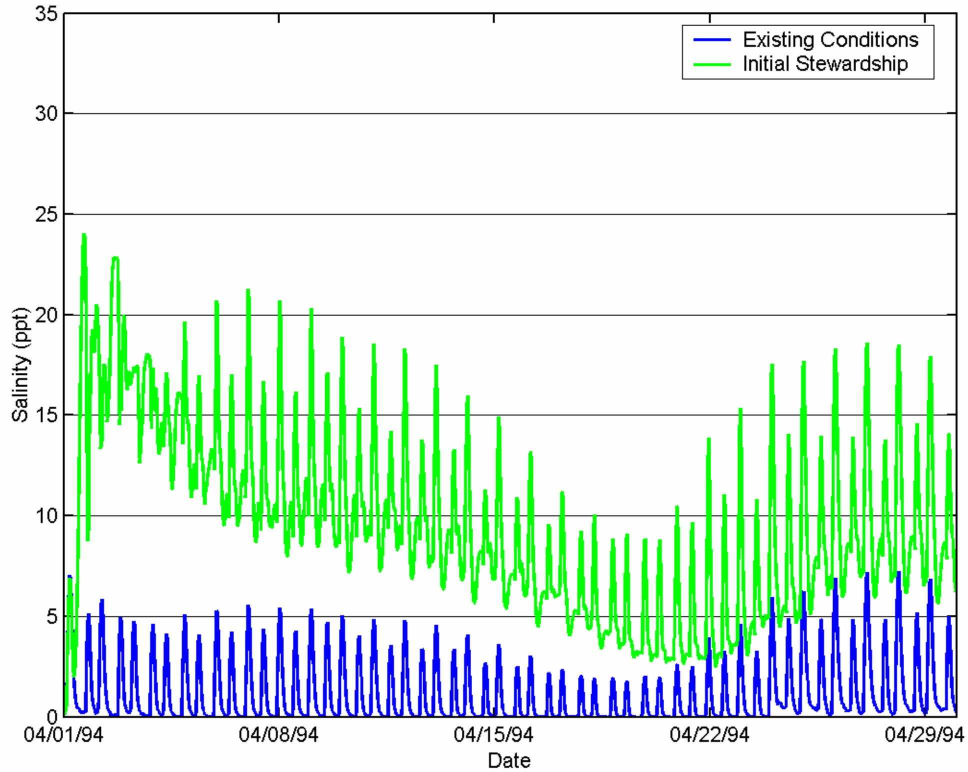
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 75. Predicted Salinity in Coyote Creek during the First Month of the Initial Release Period (Commencing April 1) at a Station 5 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".



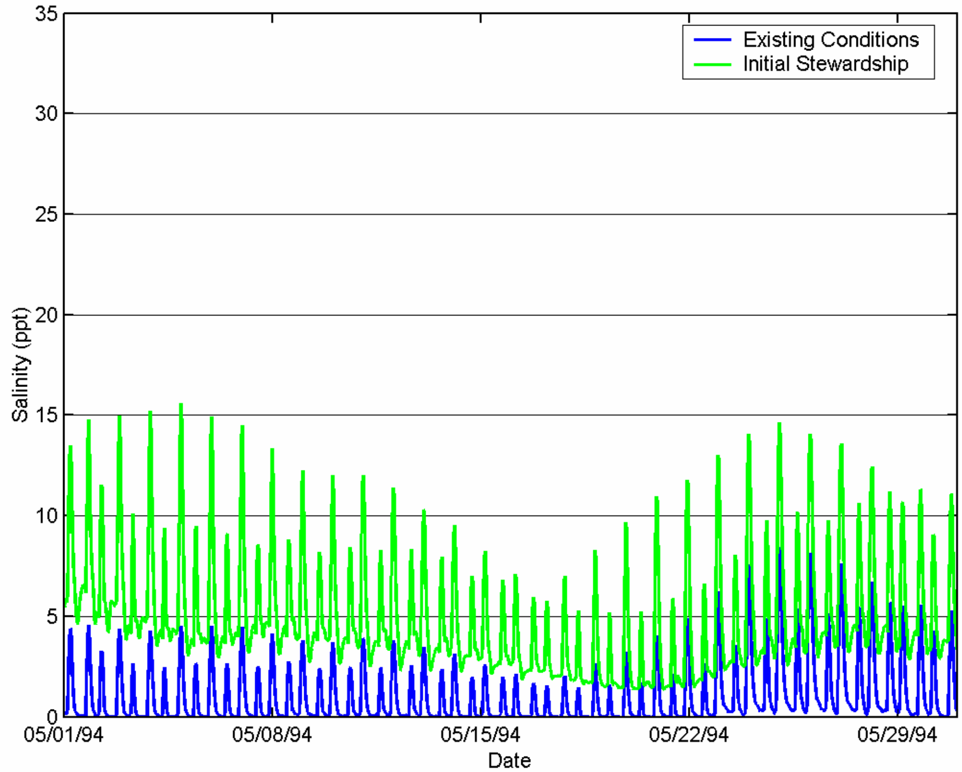
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 76. Predicted Salinity in Coyote Creek during the Second Month of the Initial Release Period (Commencing April 1) at a Station 5 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values”.



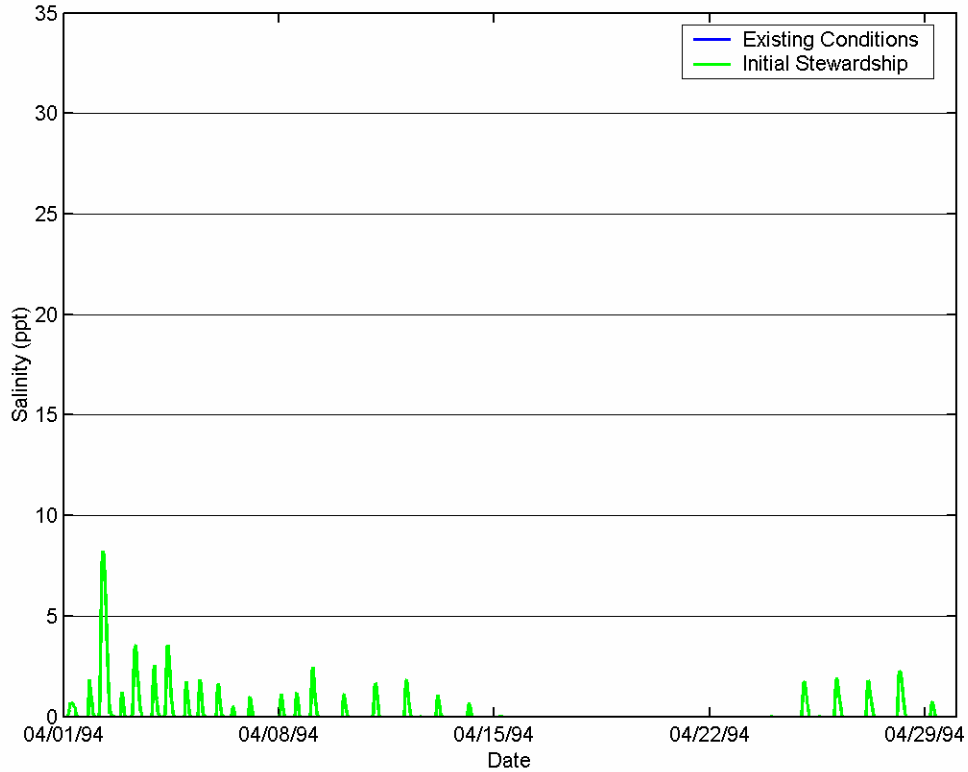
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 77. Predicted Salinity in Coyote Creek during the First Month of the Initial Release Period (Commencing April 1) at a Station 9 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values”.



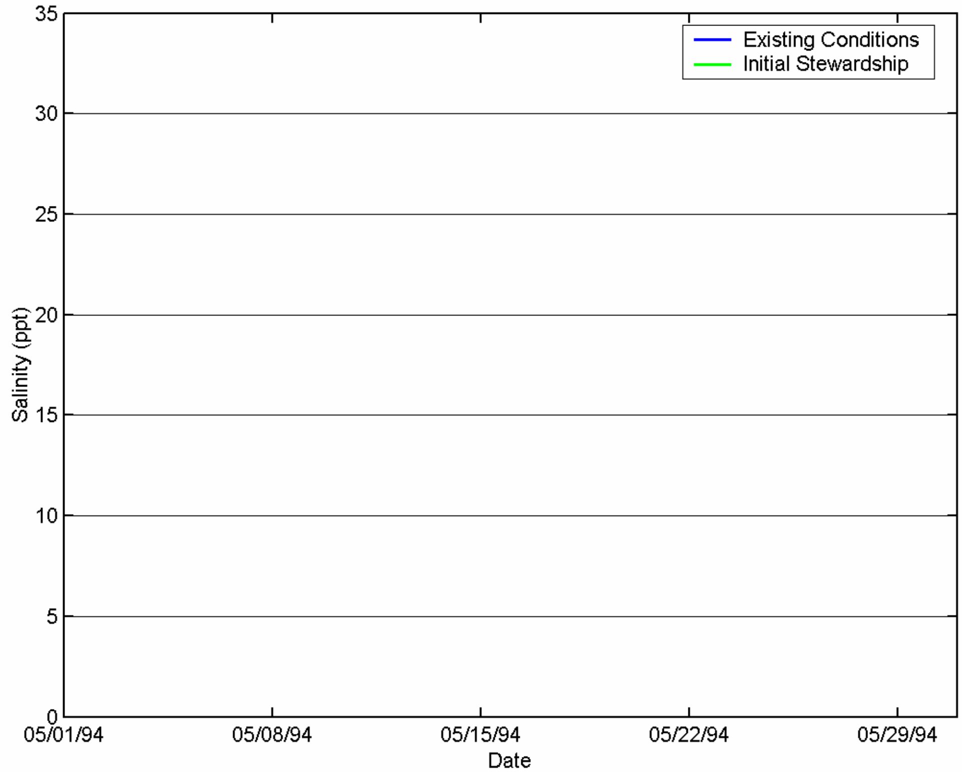
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 78. Predicted Salinity in Coyote Creek during the Second Month of the Initial Release Period (Commencing April 1) at a Station 9 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values”.



Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 79. Predicted Salinity in Coyote Creek during the First Month of the Initial Release Period (Commencing April 1) at a Station 11 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".

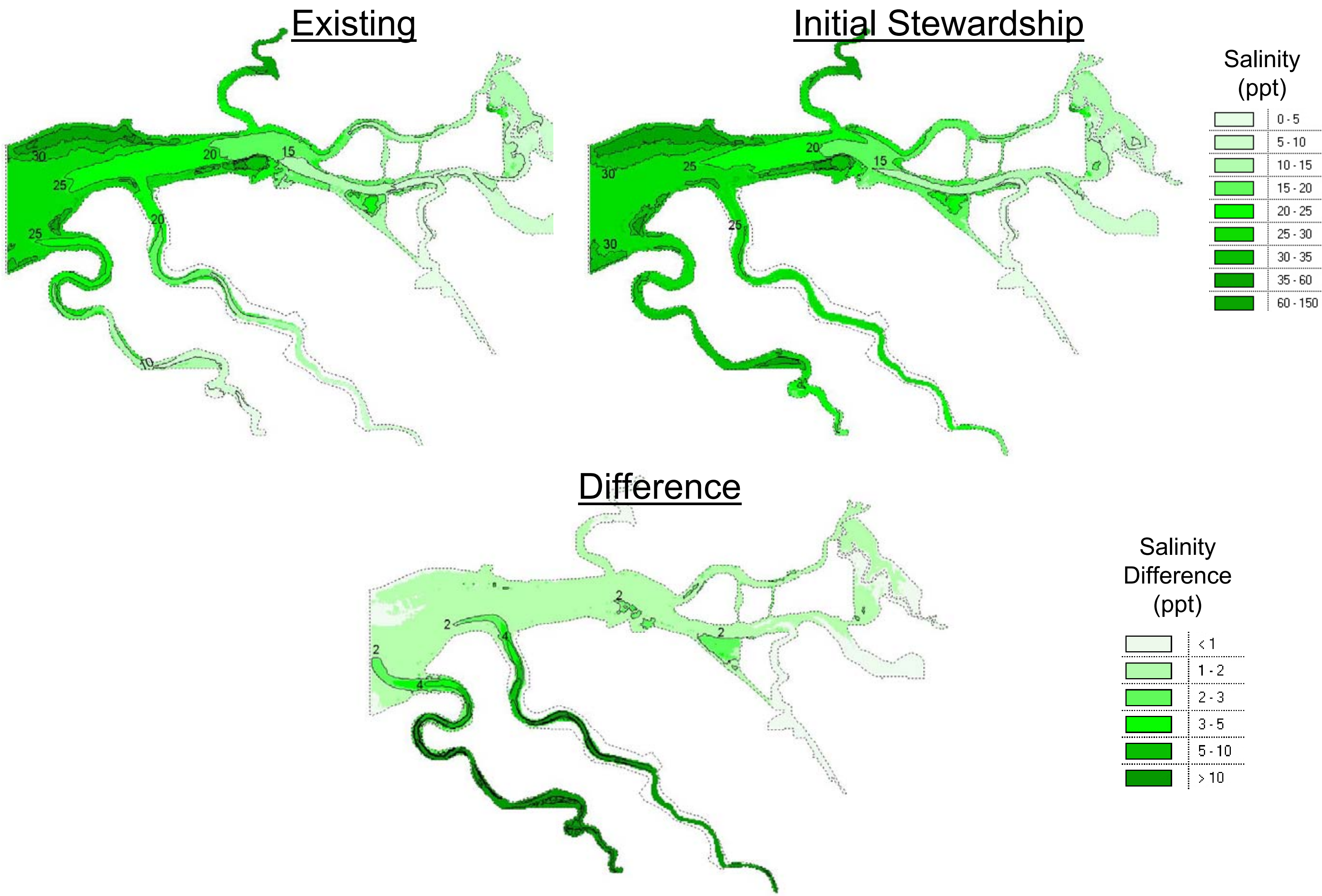


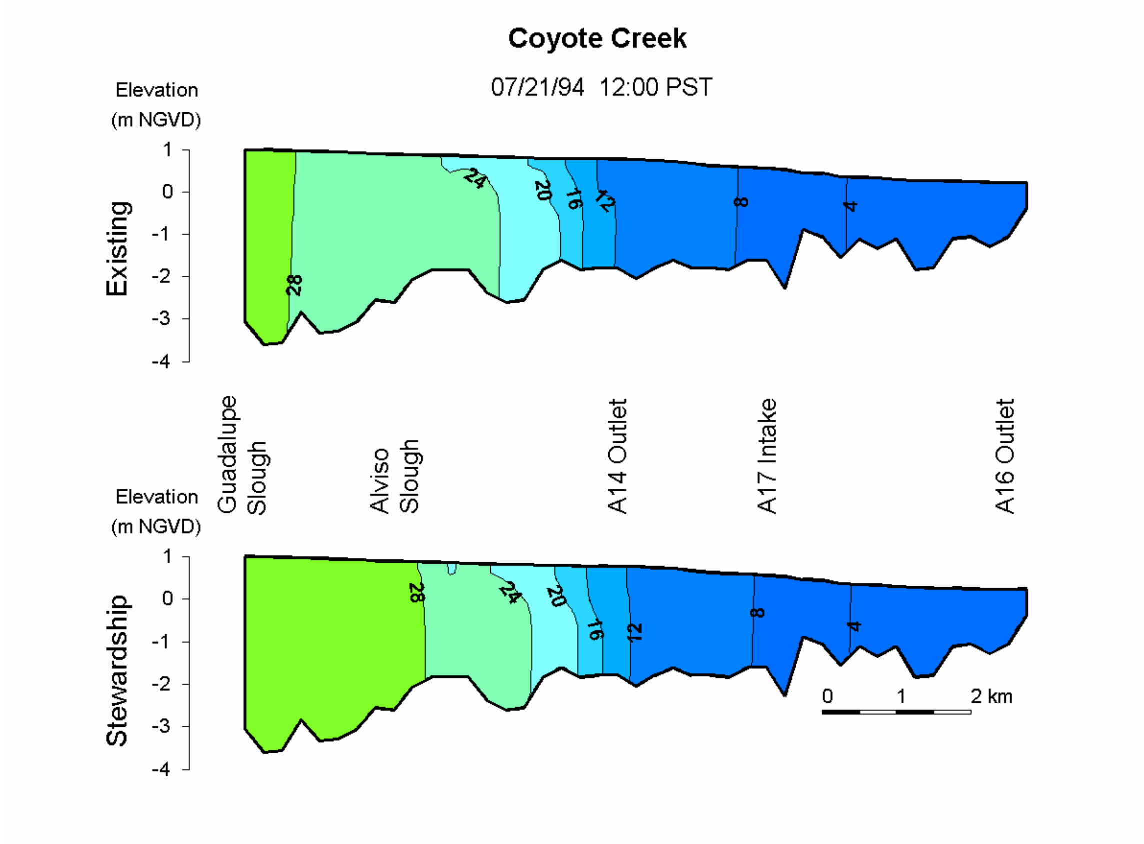
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 80. Predicted Salinity in Coyote Creek during the Second Month of the Initial Release Period (Commencing April 1) at a Station 11 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values”.

Figure 81. Predicted Salinity in Coyote Creek during **Phased Initial Release Period** after **3 Weeks** of Discharge (assumes Initial Release Commences **July 1** at **Proposed Maximum Salinity Values**)

Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.



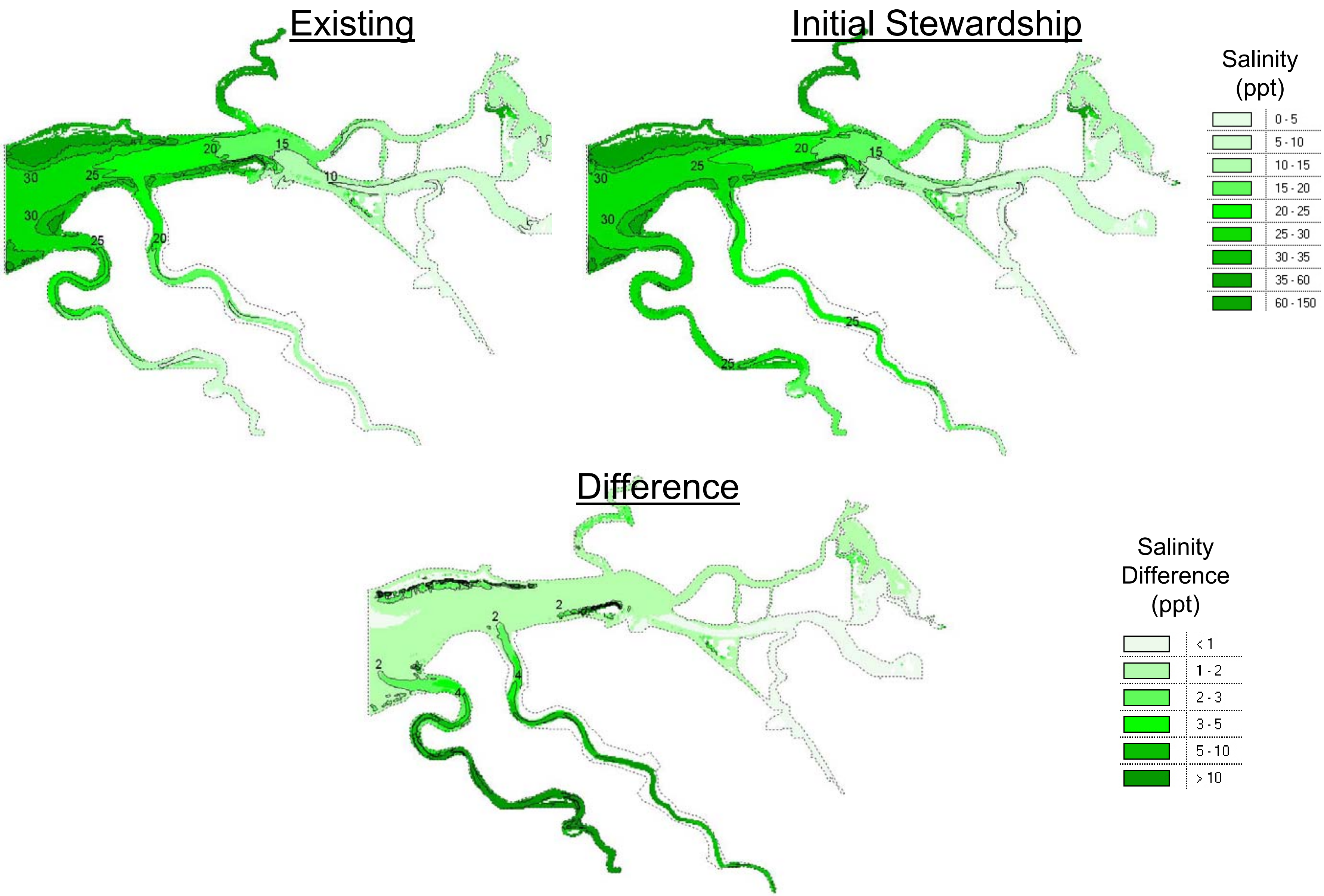


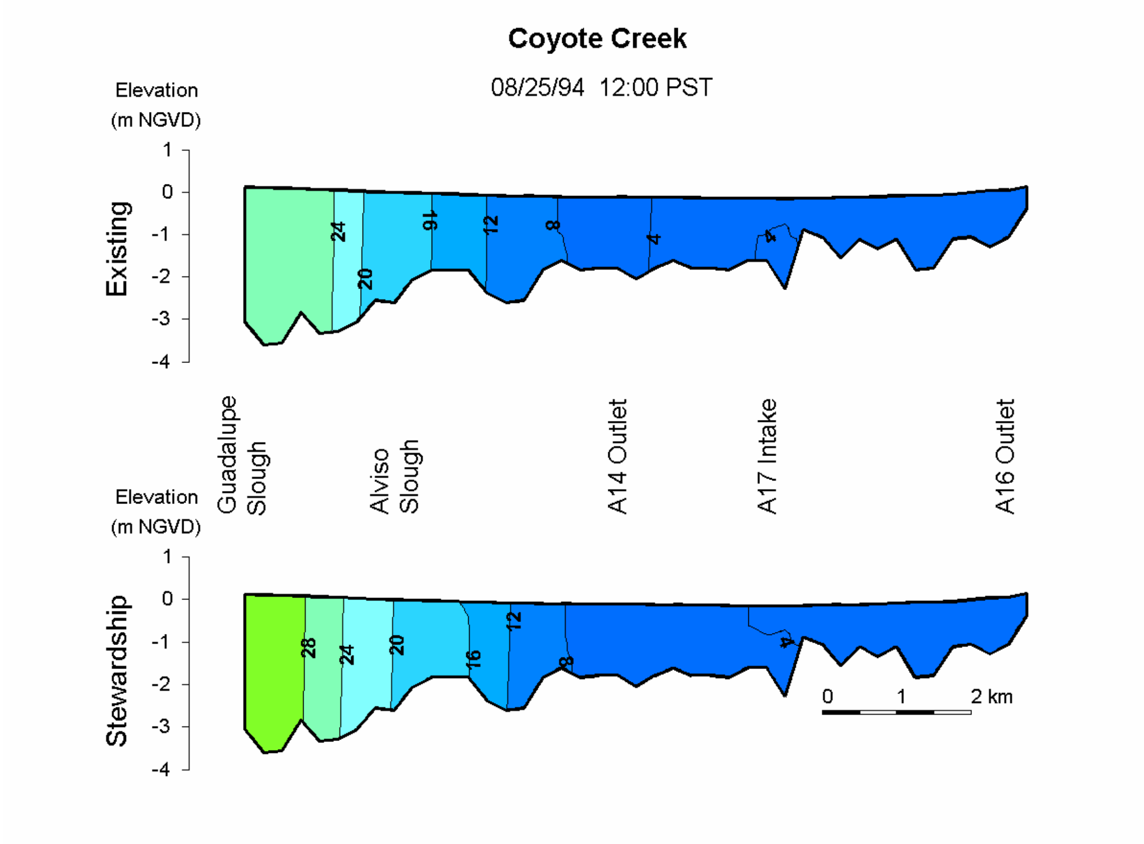
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 82. Predicted Salinity in Coyote Creek at the end of the Third Week of the Phased Initial Release Period (Commencing July 1). Comparison of Longitudinal Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".

Figure 83. Predicted Salinity in Coyote Creek during **Phased Initial Release Period** after 8 **Weeks** of Discharge (assumes Initial Release Commences **July 1** at **Proposed Maximum Salinity Values**)

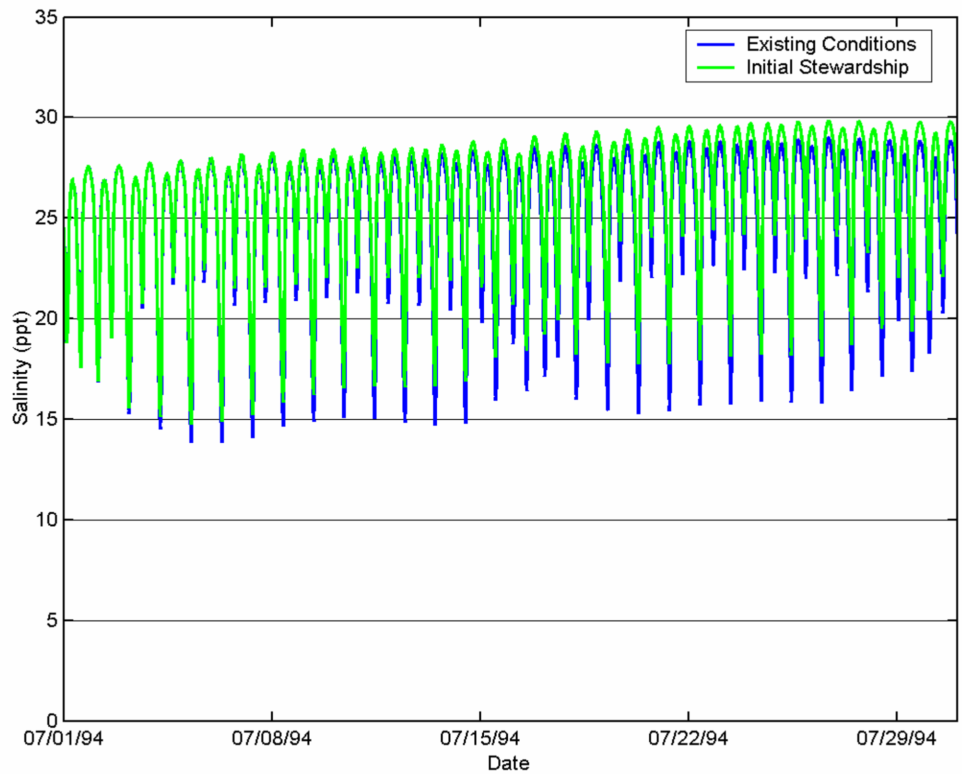
Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.





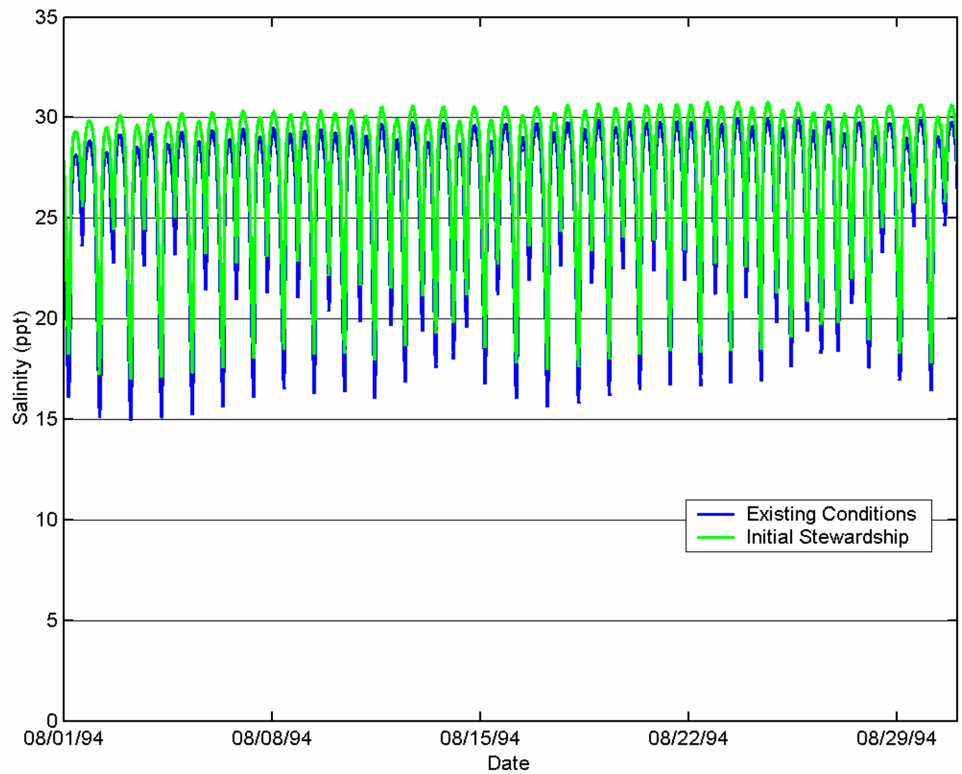
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 84. Predicted Salinity in Coyote Creek at the end of the Eighth Week of the Phased Initial Release Period (Commencing July 1). Comparison of Longitudinal Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".



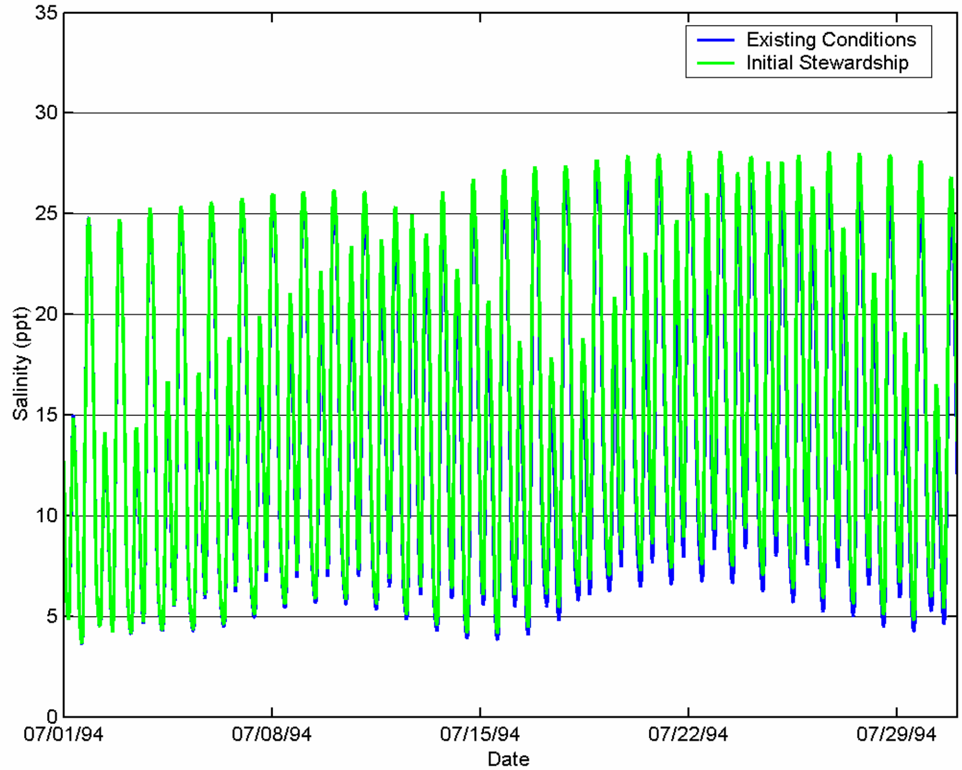
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 85. Predicted Salinity in Coyote Creek during the First Month of the Phased Initial Release Period (Commencing July 1) at a Station 1 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".



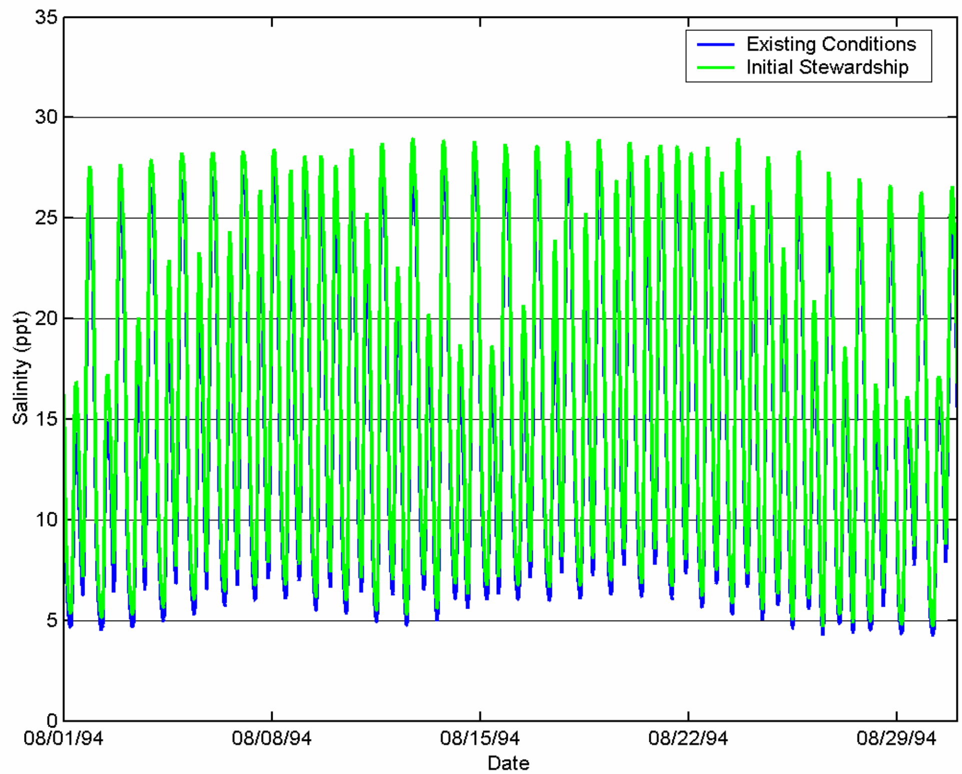
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 86. Predicted Salinity in Coyote Creek during the Second Month of the Phased Initial Release Period (Commencing July 1) at a Station 1 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".



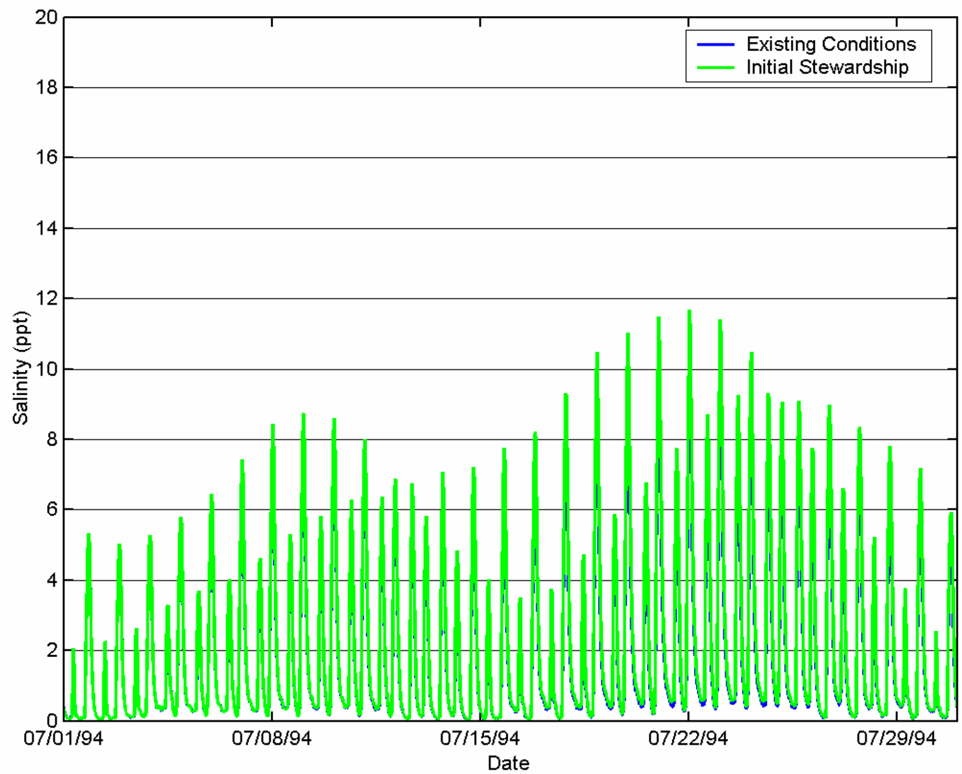
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 87. Predicted Salinity in Coyote Creek during the First Month of the Phased Initial Release Period (Commencing July 1) at a Station 5 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".



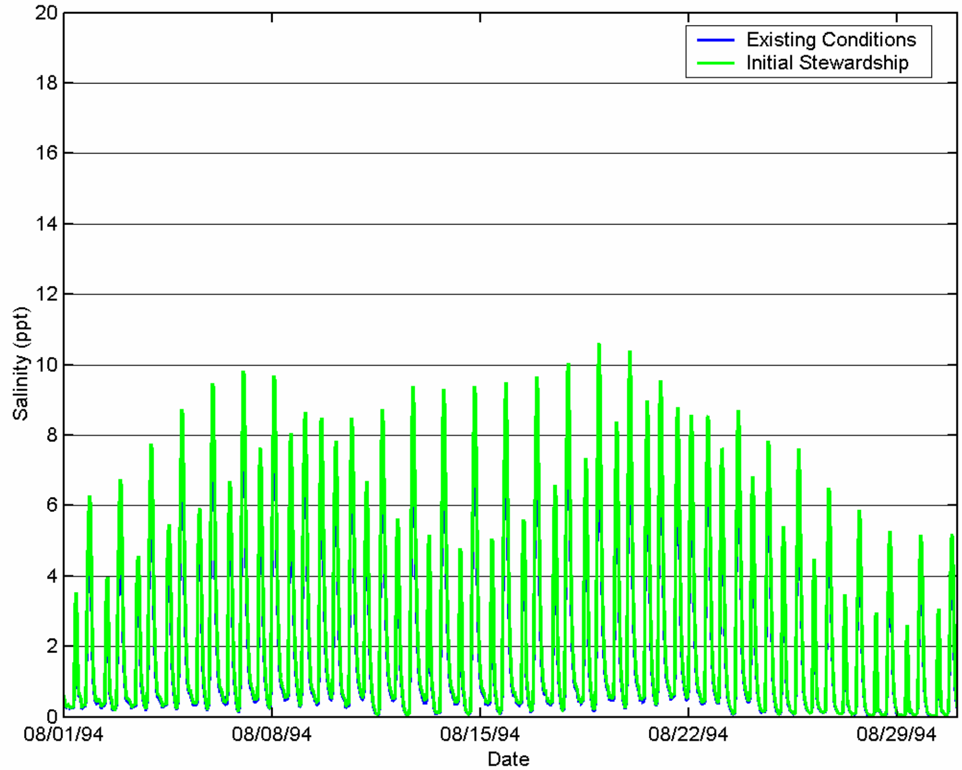
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 88. Predicted Salinity in Coyote Creek during the Second Month of the Phased Initial Release Period (Commencing July 1) at a Station 5 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".



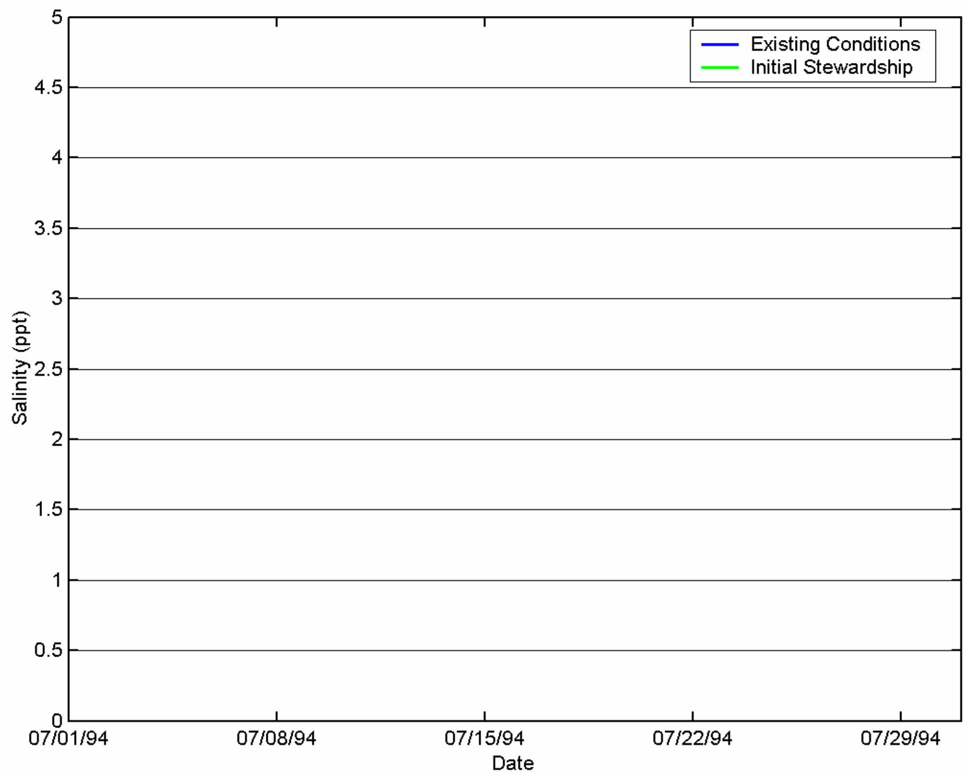
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 89. Predicted Salinity in Coyote Creek during the First Month of the Phased Initial Release Period (Commencing July 1) at a Station 9 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values”.



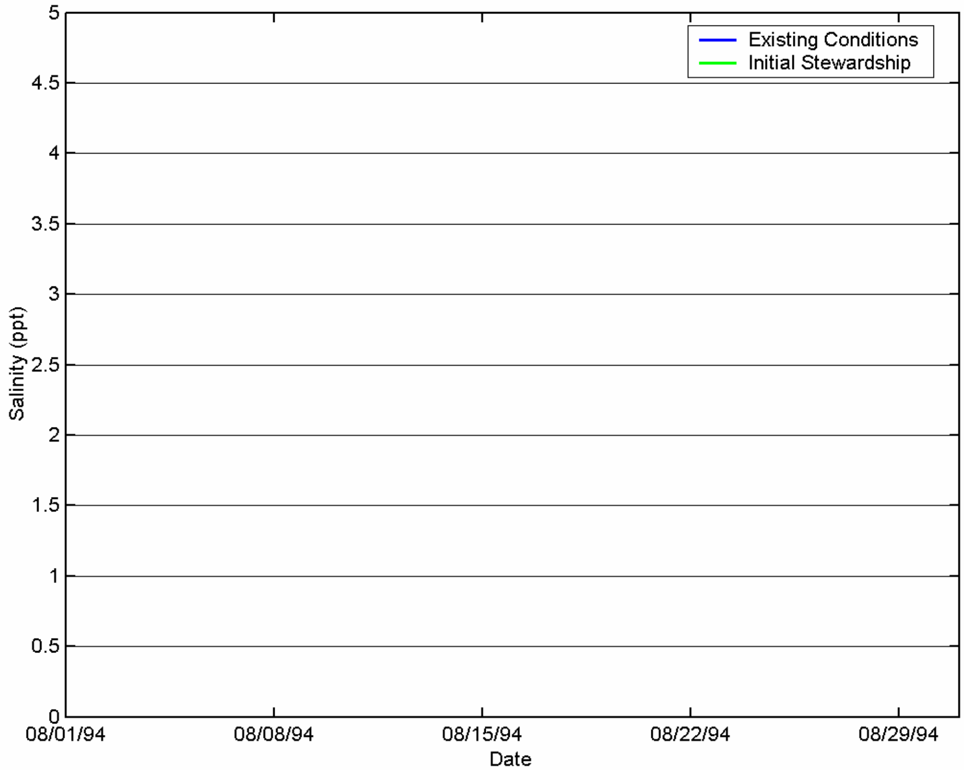
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 90. Predicted Salinity in Coyote Creek during the Second Month of the Phased Initial Release Period (Commencing July 1) at a Station 9 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".



Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 91. Predicted Salinity in Coyote Creek during the First Month of the Phased Initial Release Period (Commencing July 1) at a Station 11 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values”.

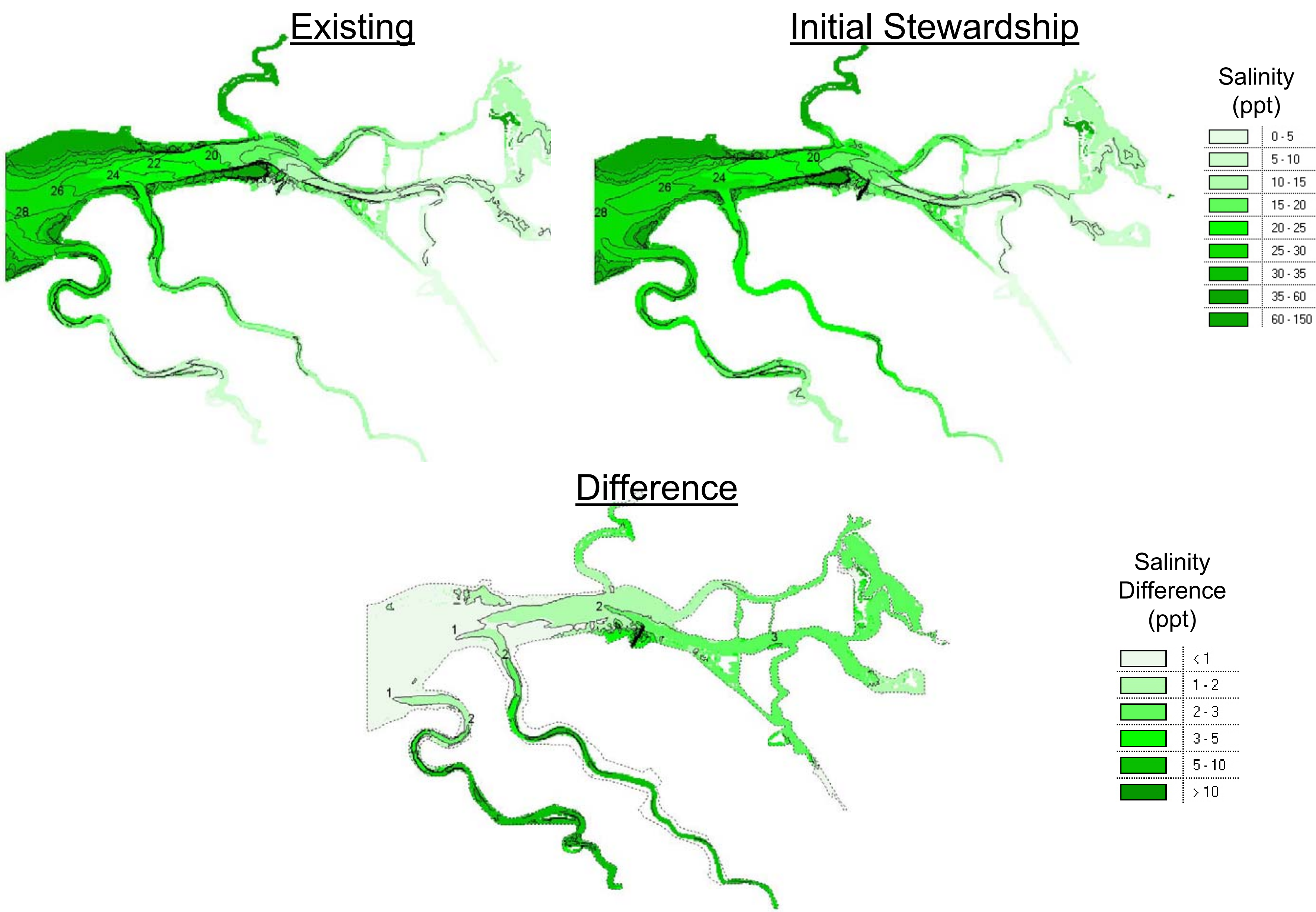


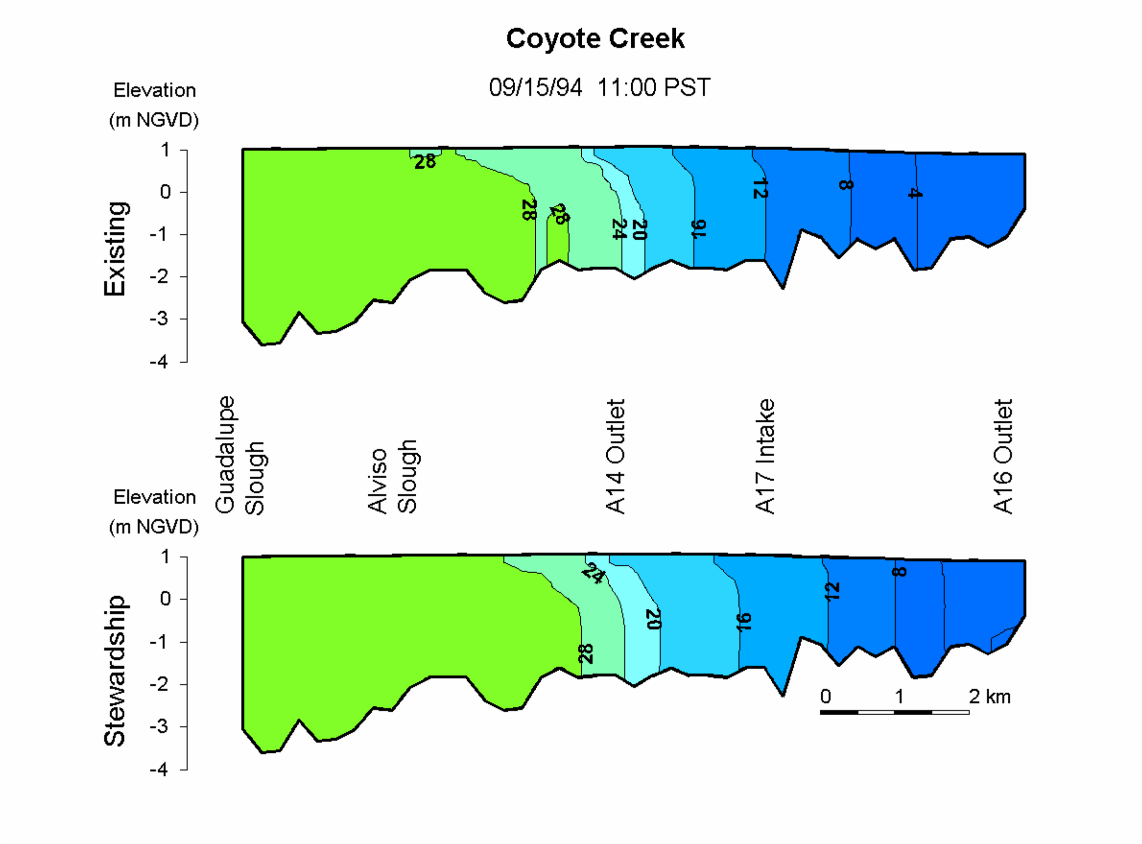
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 92. Predicted Salinity in Coyote Creek during the Second Month of the Phased Initial Release Period (Commencing July 1) at a Station 11 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".

Figure 93. Predicted Salinity in Coyote Creek during **Continuous Circulation Period** in **Late Summer**
(based on 9/15/94 conditions and assumes Initial Release has been completed)

Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.





Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 94. Predicted Salinity in Coyote Creek in mid-September during the Continuous Circulation Period. Comparison of Longitudinal Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Continuous Circulation Salinity Values".

Figure 95. Predicted Salinity in Coyote Creek during **Continuous Circulation Period** in **Winter Storm Event**
(based on 2/20/95 conditions and assumes Initial Release has been completed)

Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.

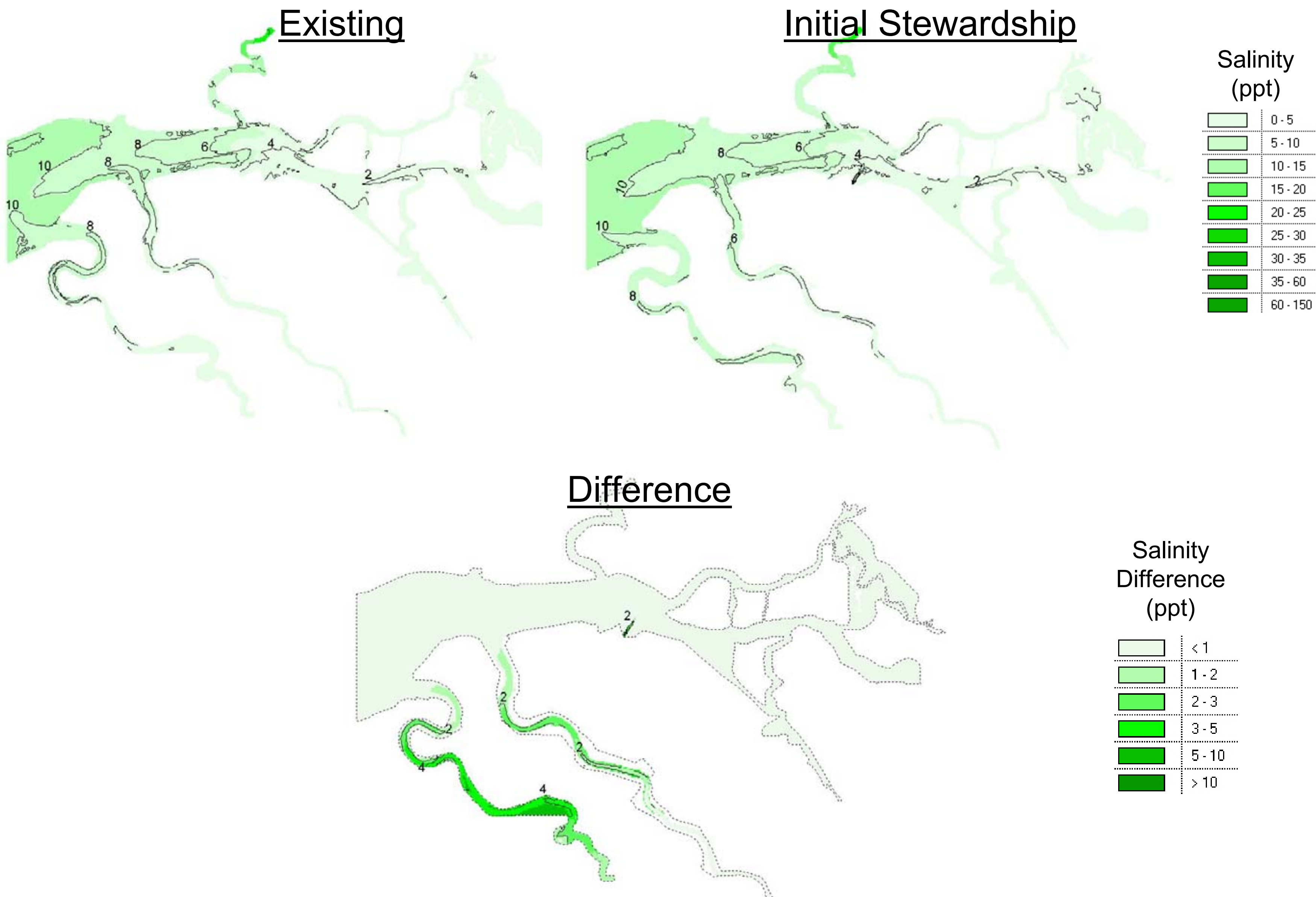
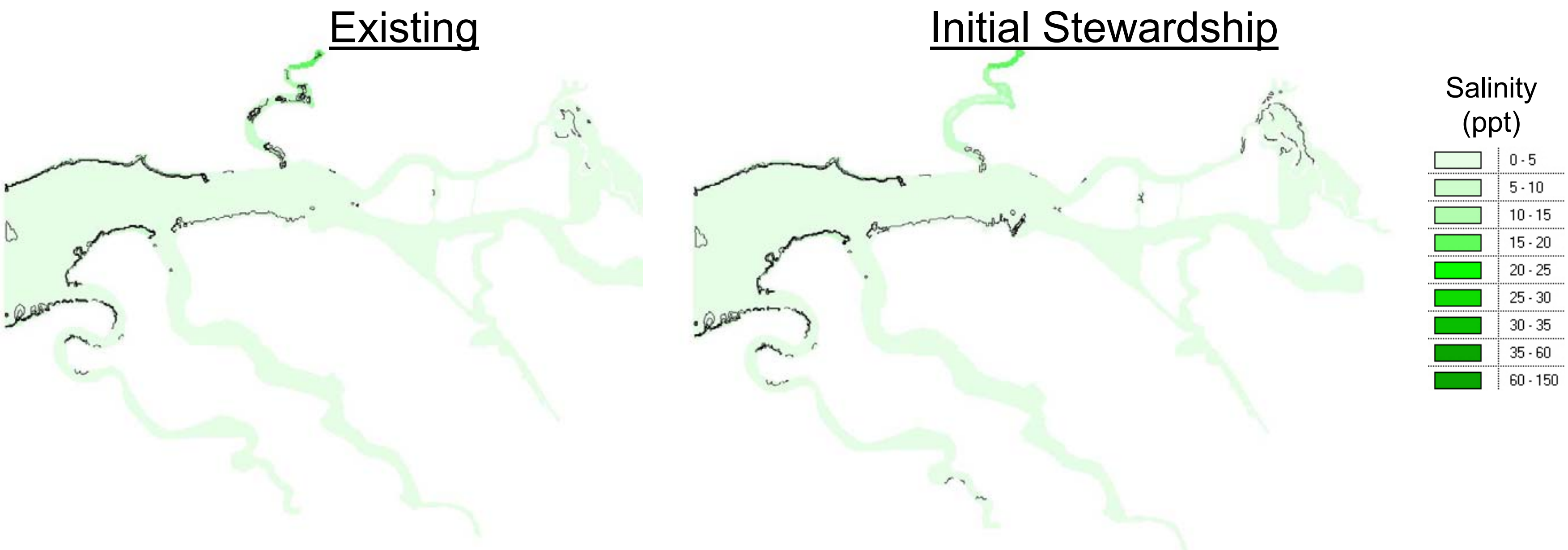


Figure 96. Predicted Salinity in Coyote Creek during **Continuous Circulation Period** in **Winter Dry Period**
(based on 3/10/95 conditions and assumes Initial Release has been completed)

Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.



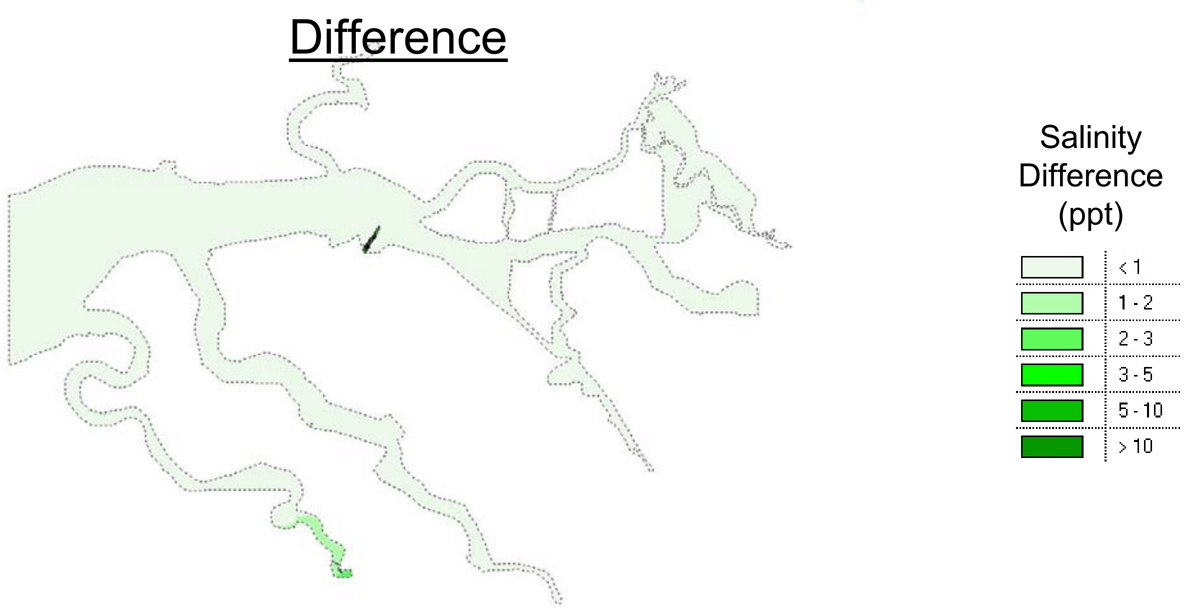
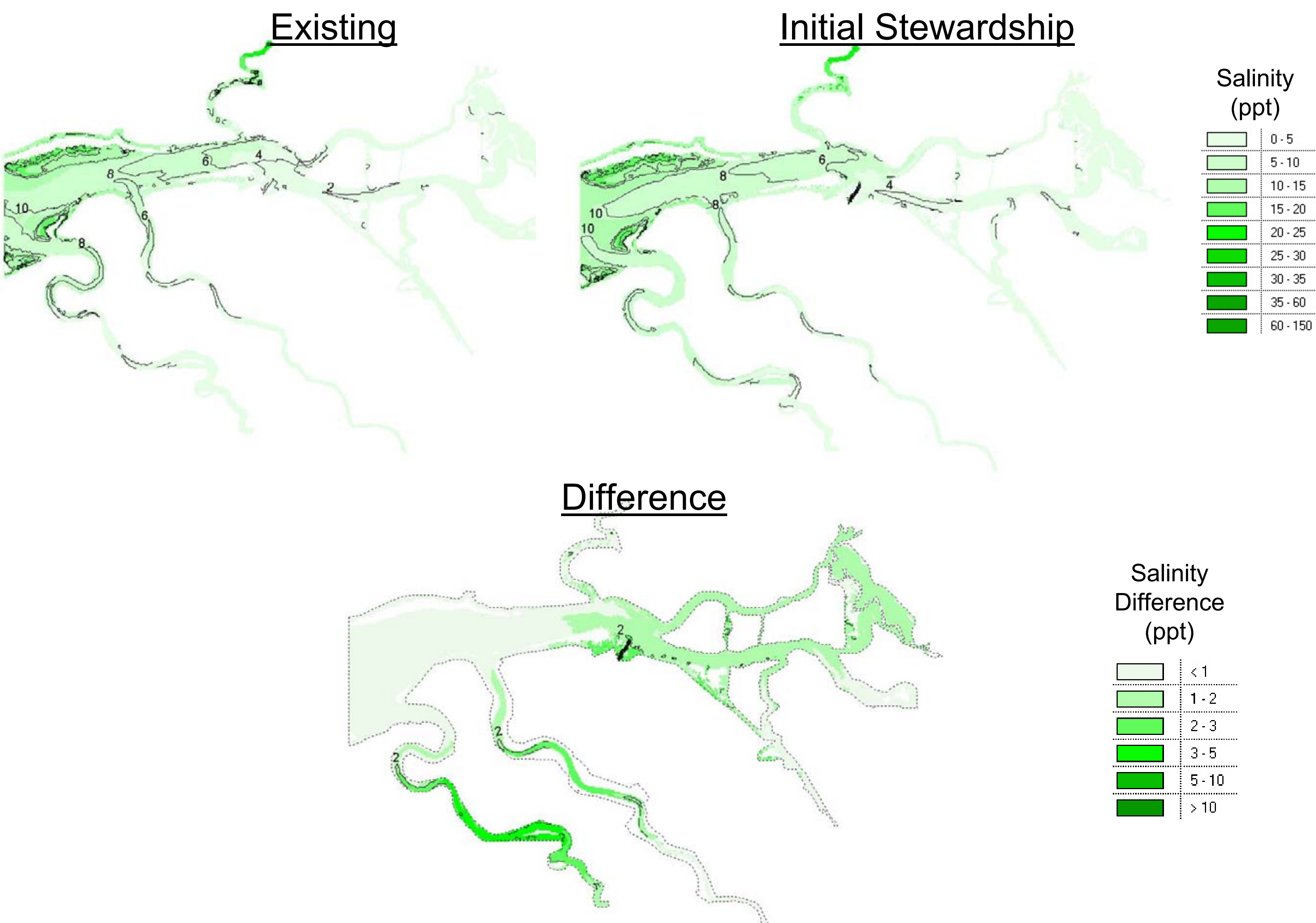


Figure 97. Predicted Salinity in Coyote Creek during **Continuous Circulation Period** in **Late Spring**
(based on 6/1/95 conditions and assumes Initial Release has been completed)

Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.



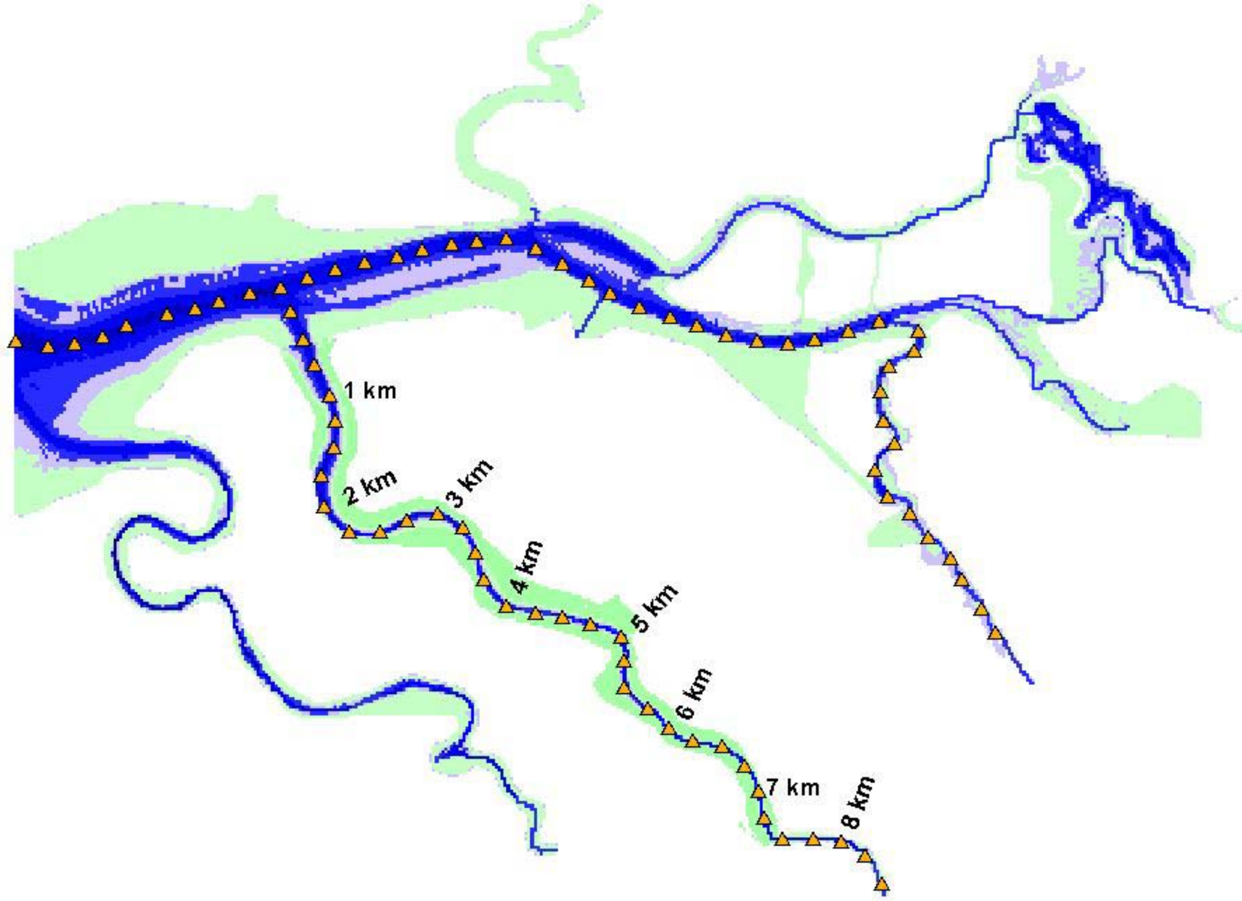
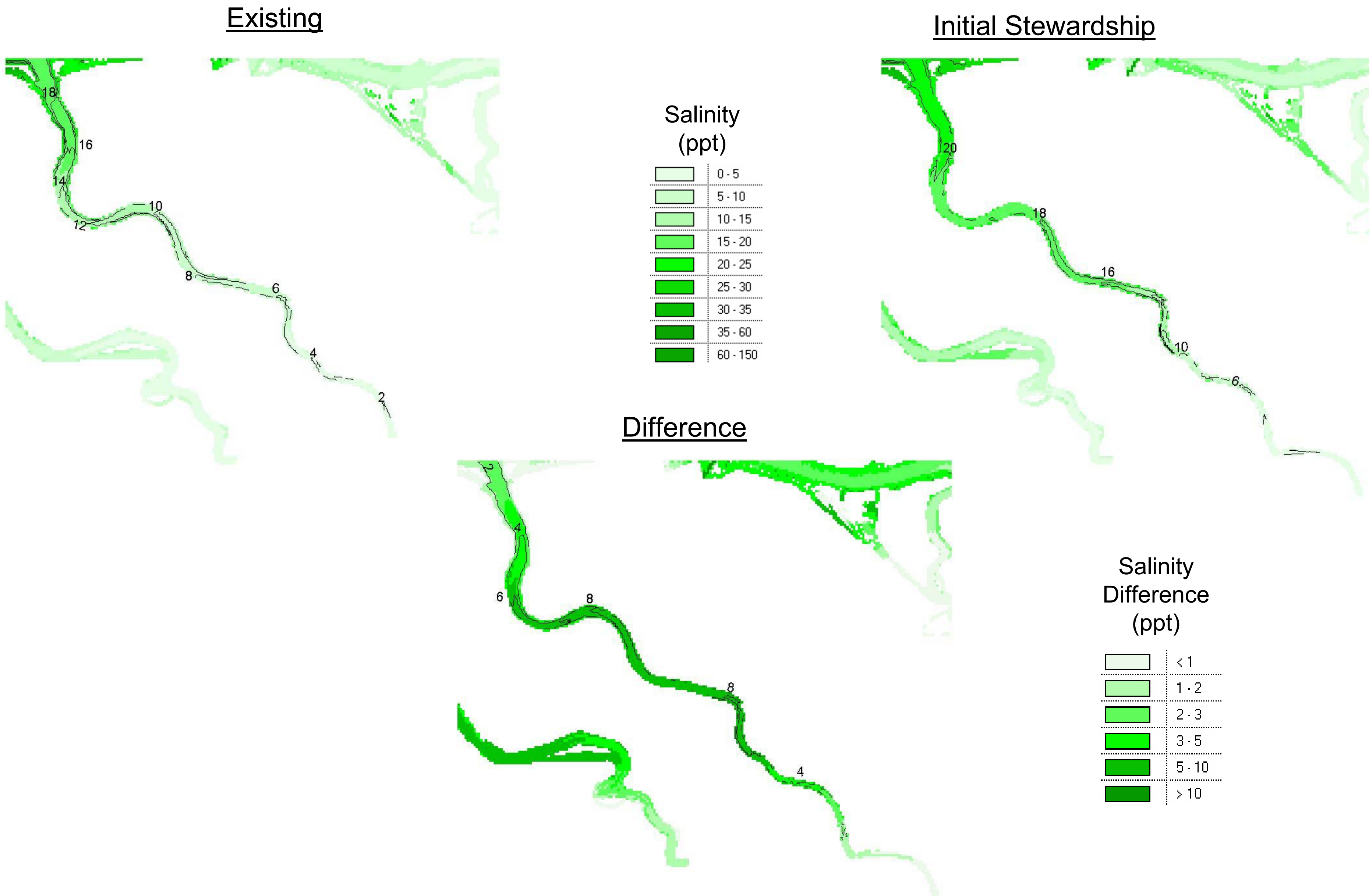
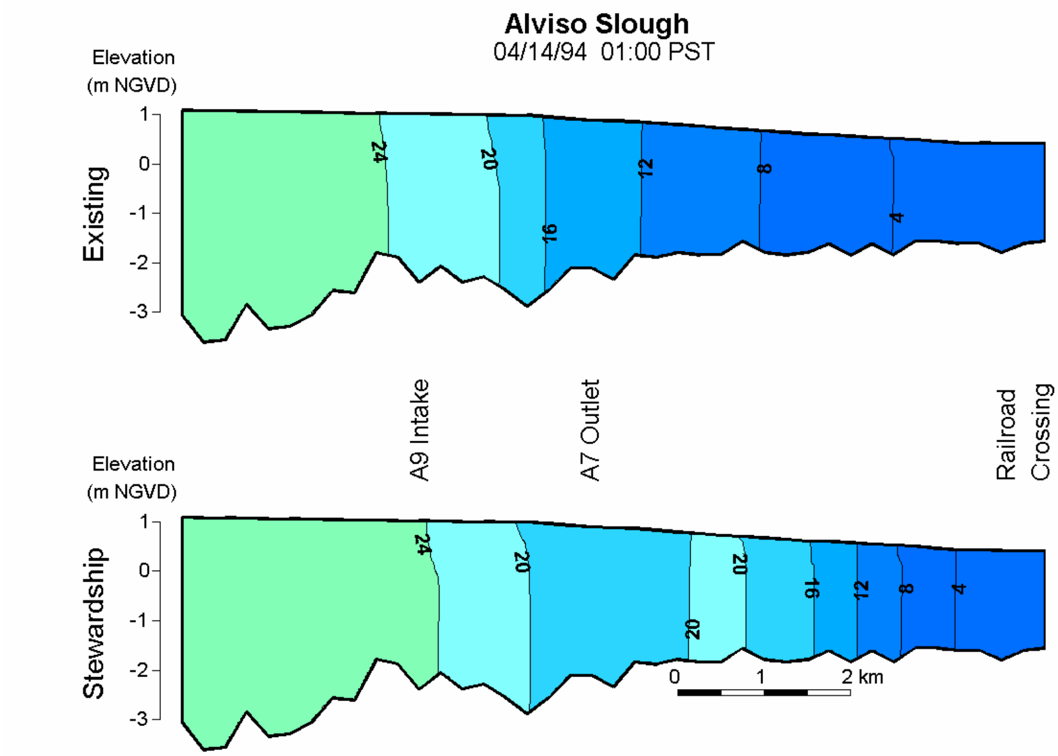


Figure 98. Distances along Alviso Slough – starting at its mouth and moving upstream.

Figure 99. Predicted Salinity in Alviso Slough during **Initial Release Period** after **2 Weeks** of Discharge
(assumes Initial Release Commences **April1** at **2002 Salinity Values**)

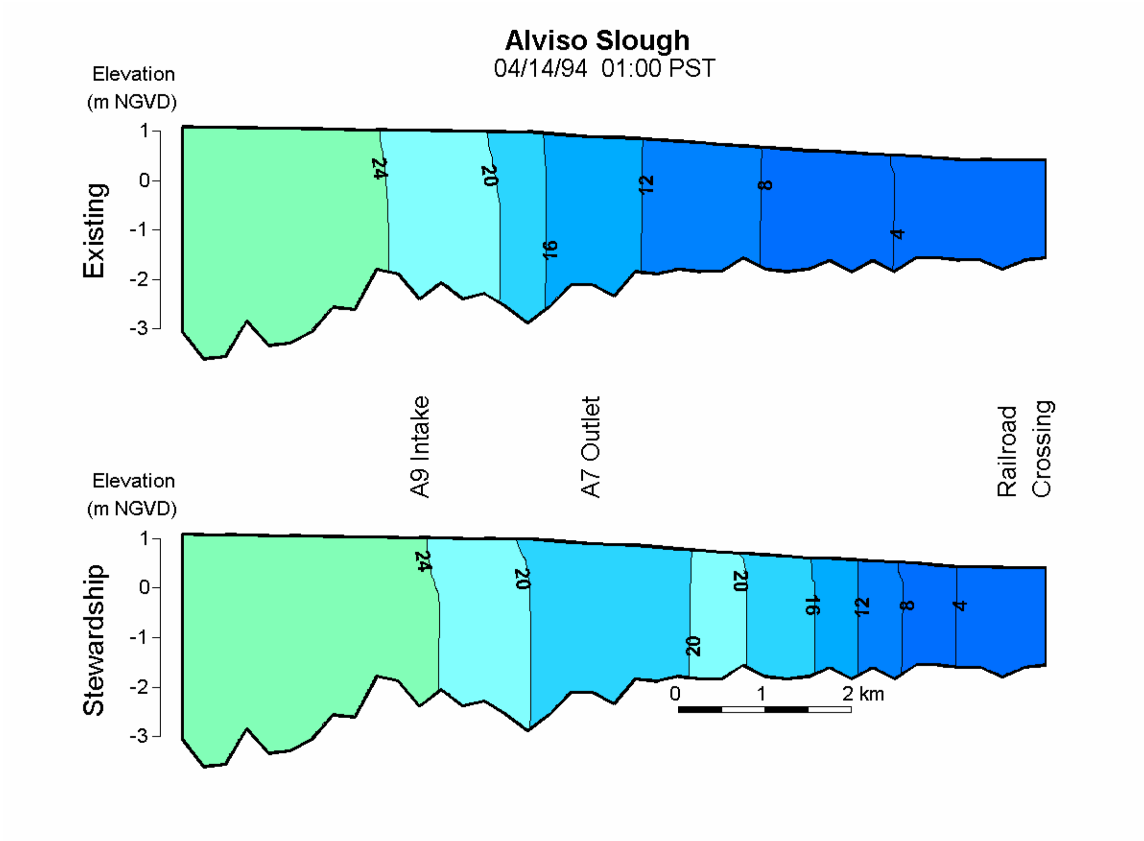
Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.





Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 100. Predicted Salinity in Alviso Slough at the end of the Second Week of the Initial Release Period (Commencing April 1). Comparison of Longitudinal Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at 2002 Salinity Values".

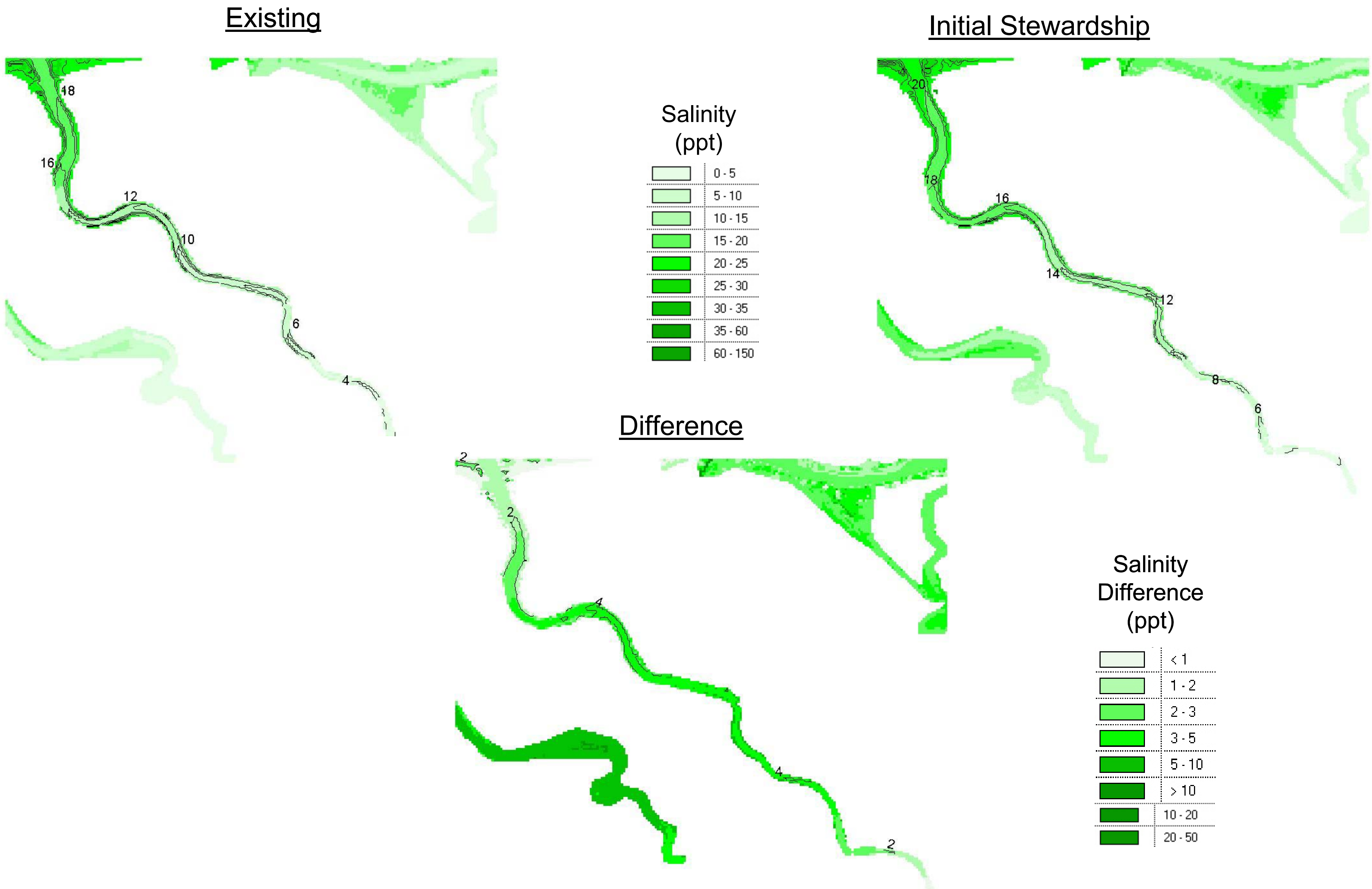


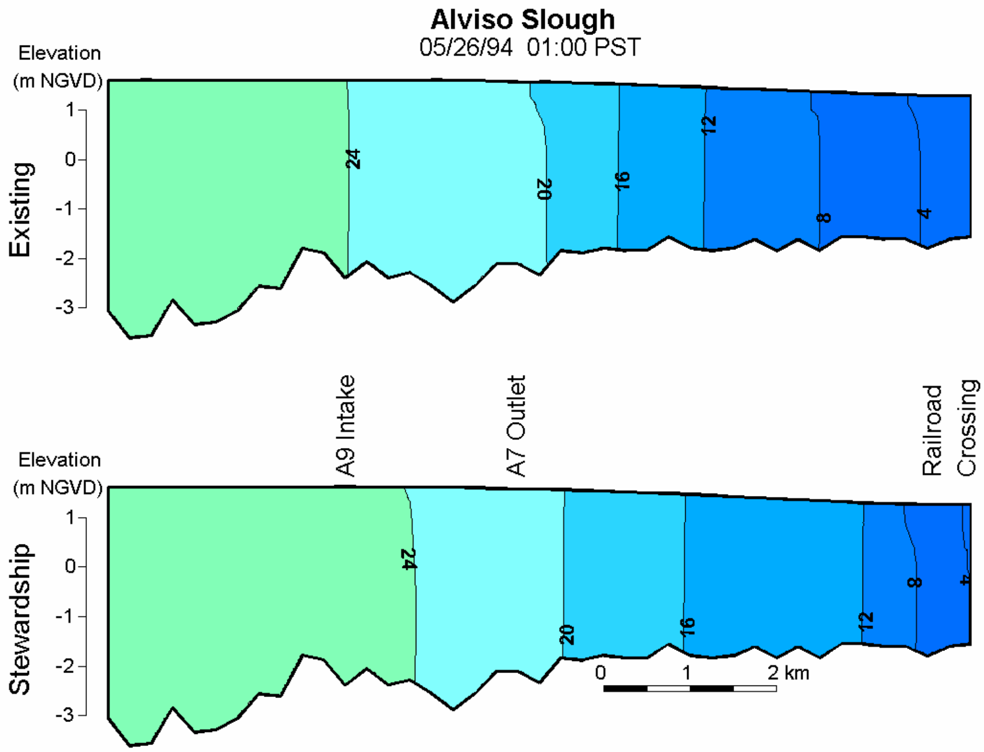
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 100. Predicted Salinity in Alviso Slough at the end of the Second Week of the Initial Release Period (Commencing April 1). Comparison of Longitudinal Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at 2002 Salinity Values”.

Figure 101. Predicted Salinity in Alviso Slough during **Initial Release Period** after **8 Weeks** of Discharge
(assumes Initial Release Commences **April1** at **2002 Salinity Values**)

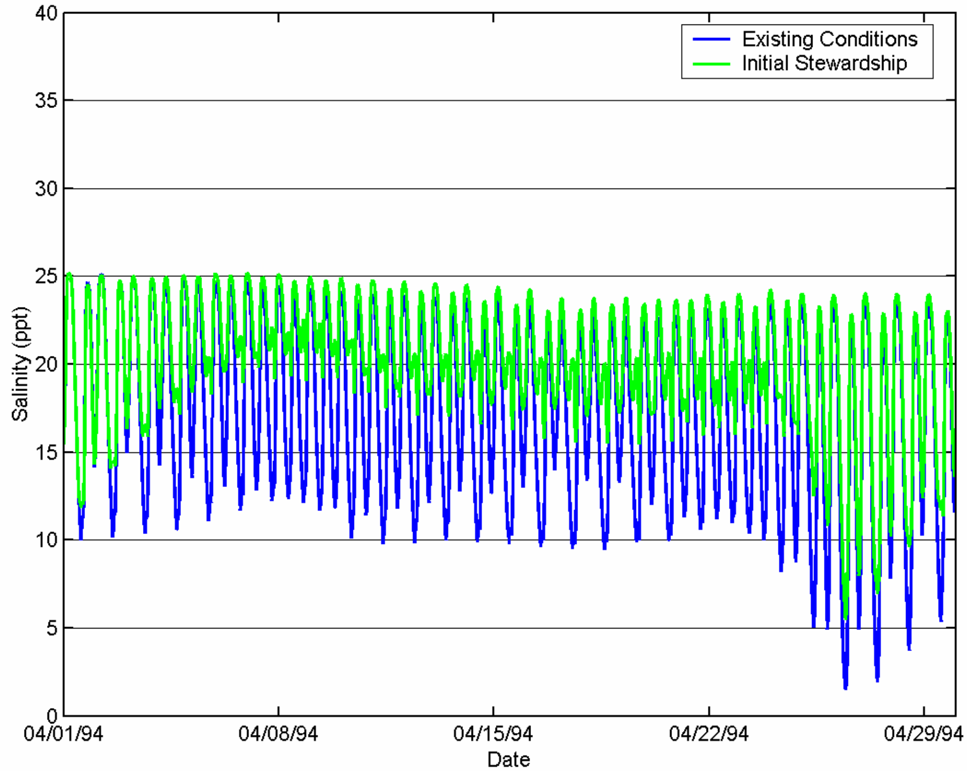
Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.





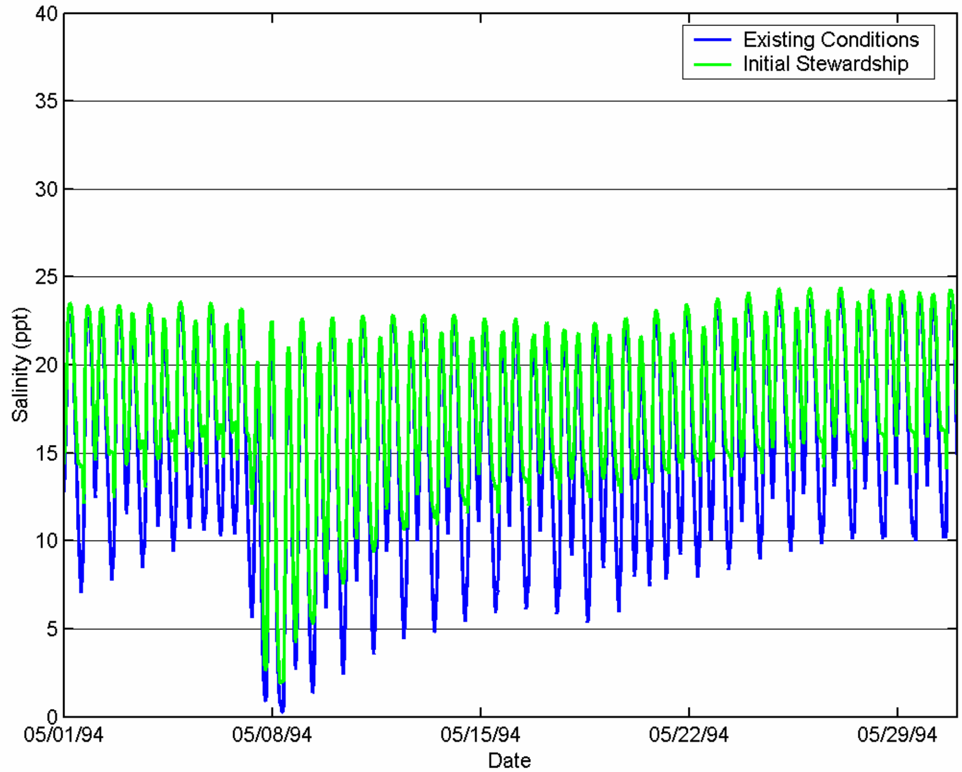
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 102. Predicted Salinity in Alviso Slough at the end of the Eighth Week of the Initial Release Period (Commencing April 1). Comparison of Longitudinal Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at 2002 Salinity Values”.



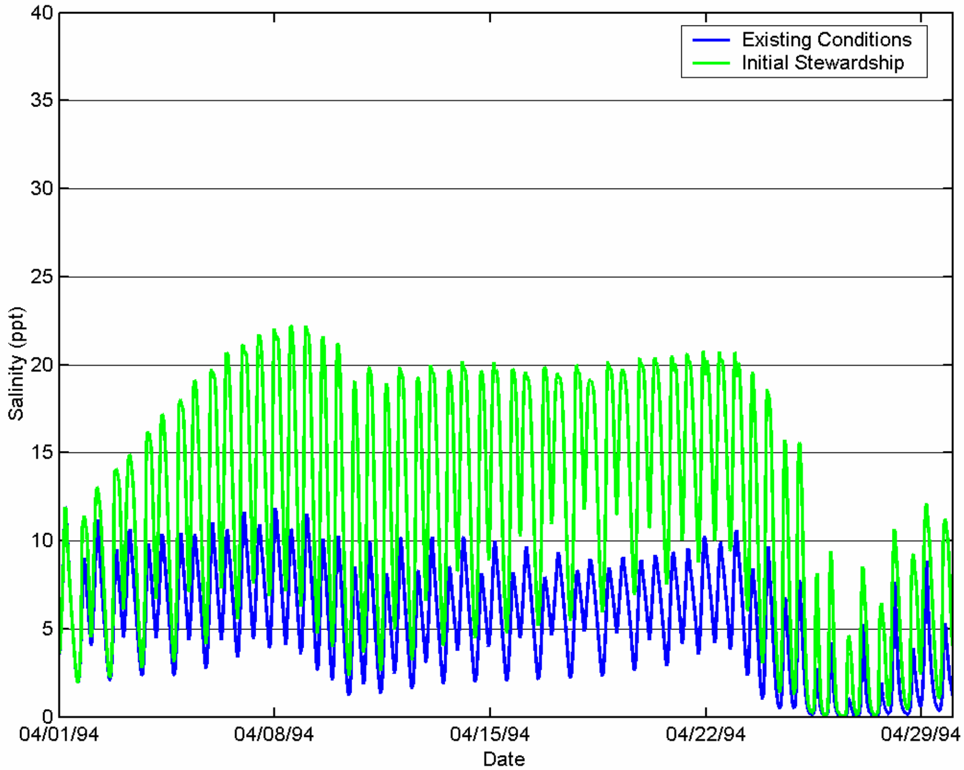
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 103. Predicted Salinity in Alviso Slough during the First Month of the Initial Release Period (Commencing April 1) at a Station 1 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at 2002 Salinity Values".



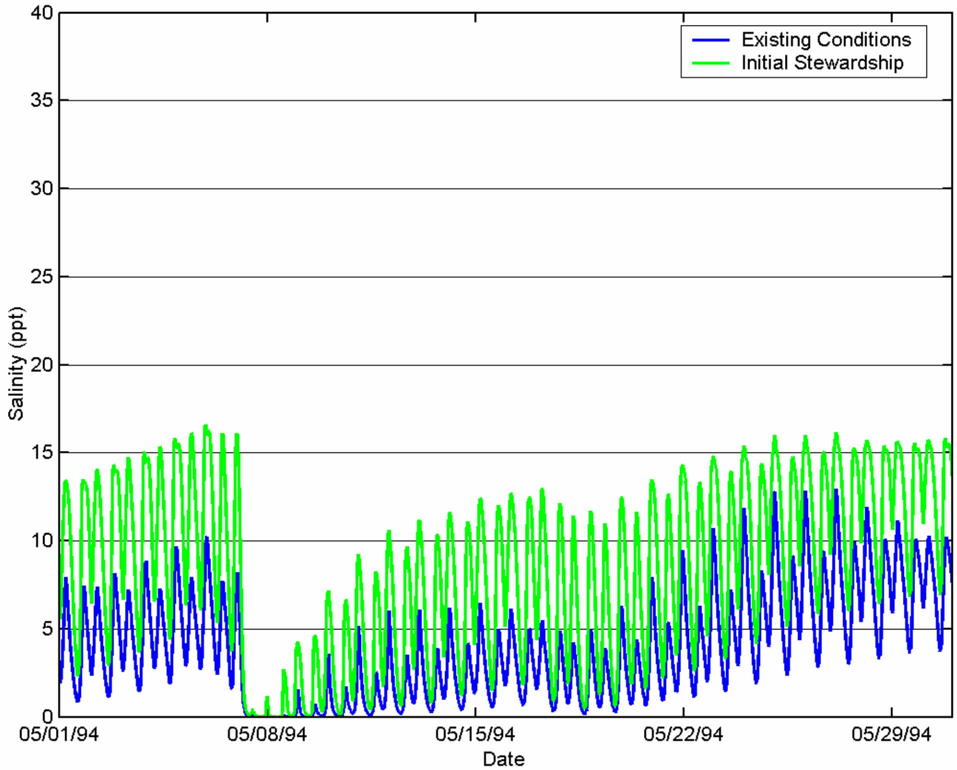
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 104. Predicted Salinity in Alviso Slough during the Second Month of the Initial Release Period (Commencing April 1) at a Station 1 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at 2002 Salinity Values".



Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 105. Predicted Salinity in Alviso Slough during the First Month of the Initial Release Period (Commencing April 1) at a Station 5 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at 2002 Salinity Values”.

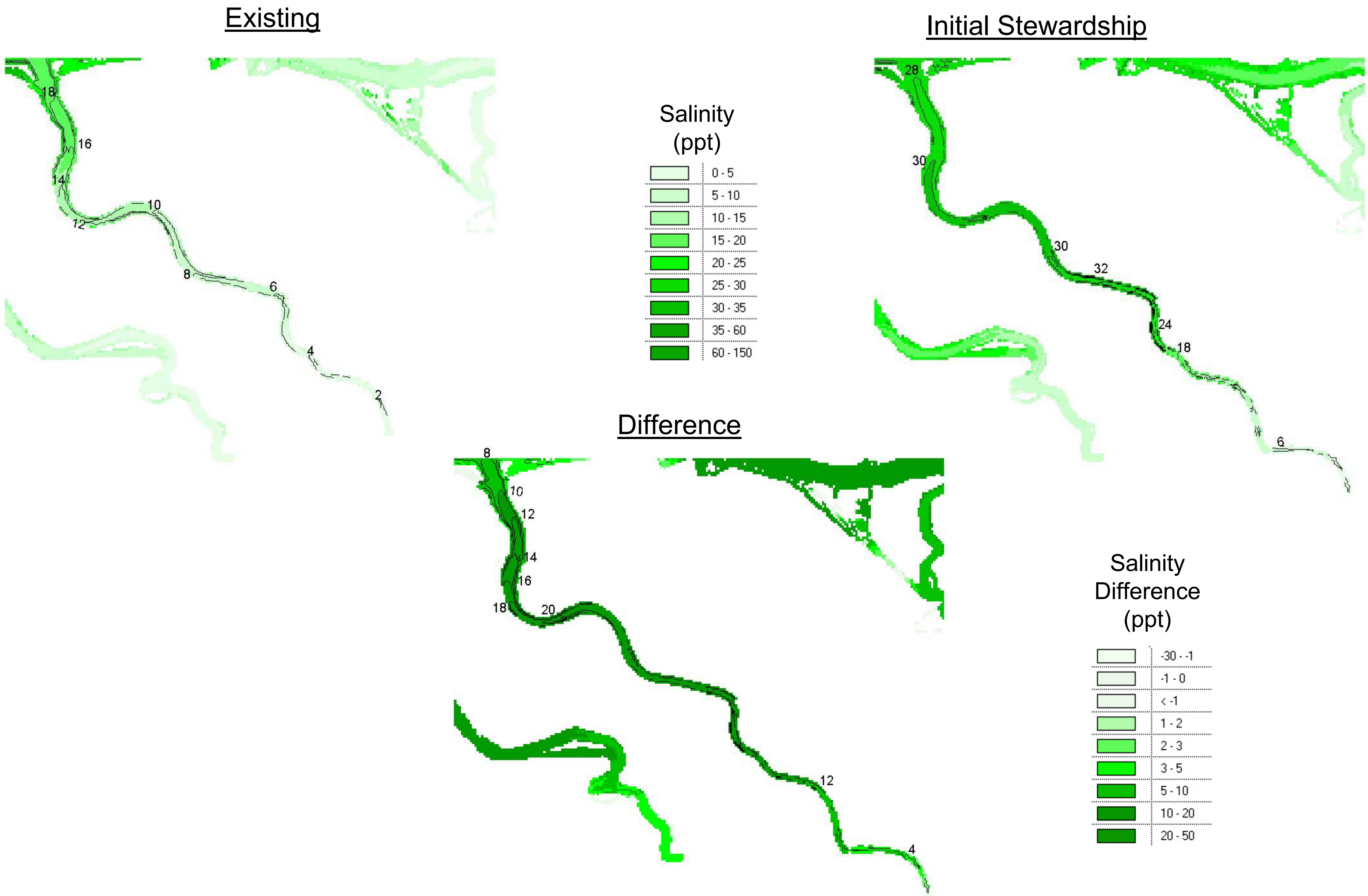


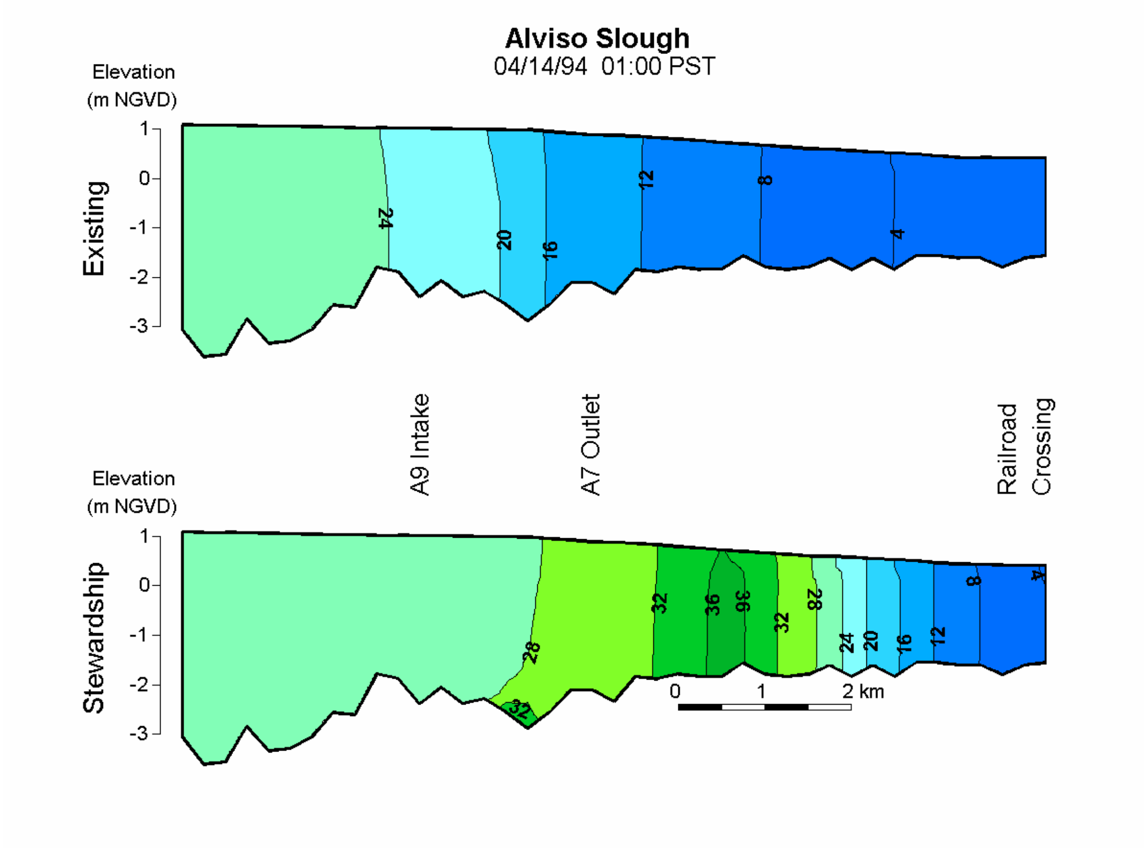
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 106. Predicted Salinity in Alviso Slough during the Second Month of the Initial Release Period (Commencing April 1) at a Station 5 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at 2002 Salinity Values".

Figure 107. Predicted Salinity in Alviso Slough during **Initial Release Period** after **2 Weeks** of Discharge
(assumes Initial Release Commences **April1** at **Proposed Maximum Salinity Values**)

Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.



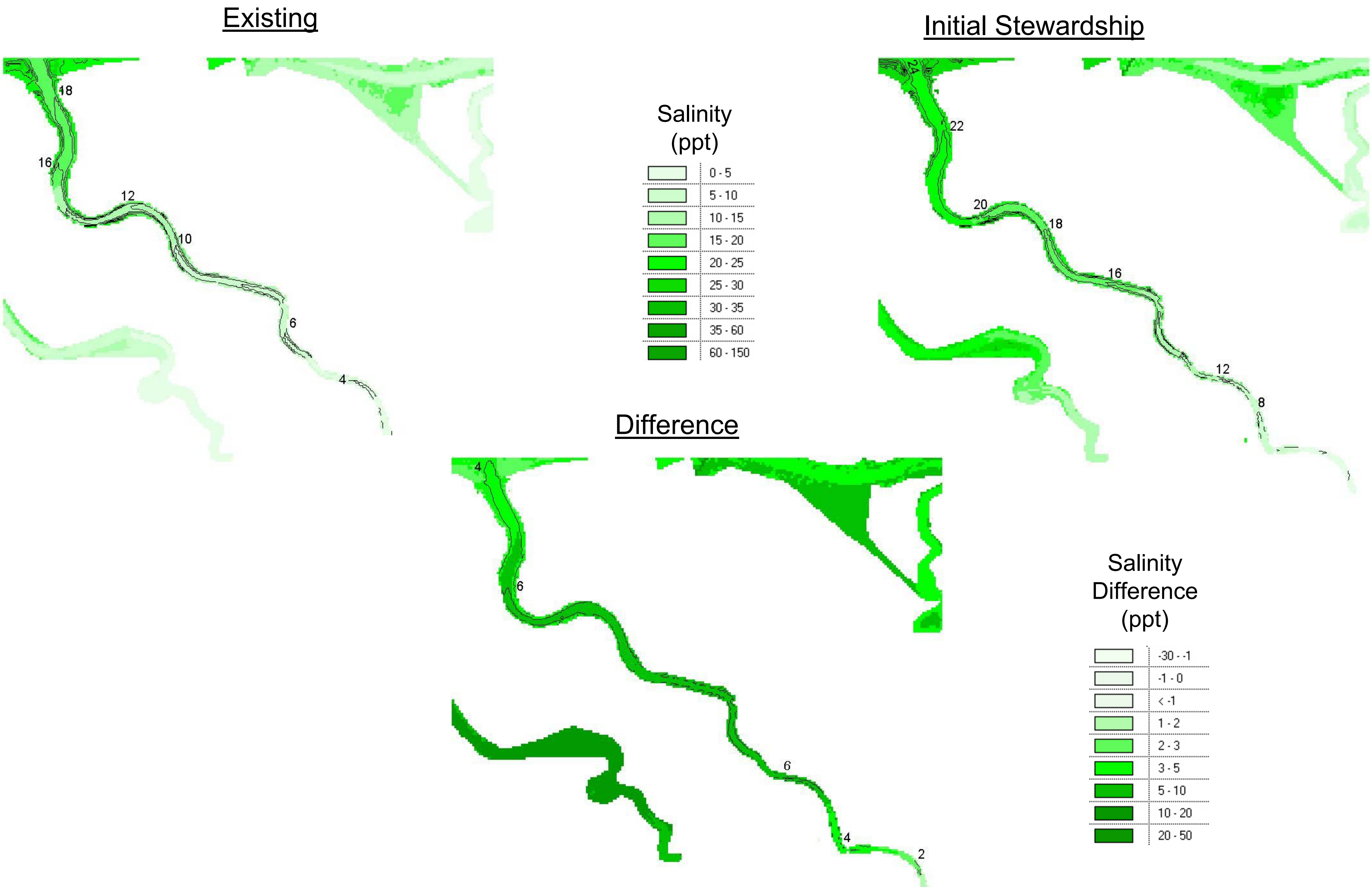


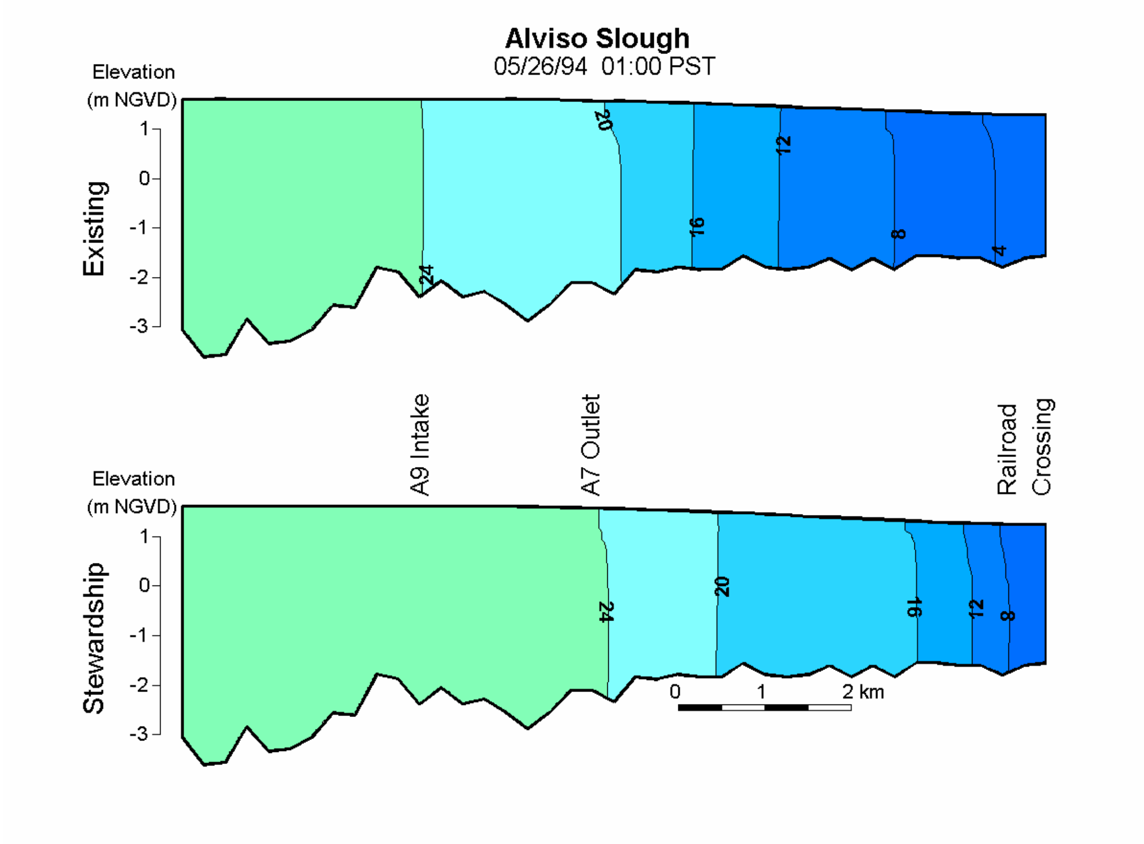
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 108. Predicted Salinity in Alviso Slough at the end of the Second Week of the Initial Release Period (Commencing April 1). Comparison of Longitudinal Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values”.

Figure 109. Predicted Salinity in Alviso Slough during **Initial Release Period** after **8 Weeks** of Discharge
(assumes Initial Release Commences **April1** at **Proposed Maximum Salinity Values**)

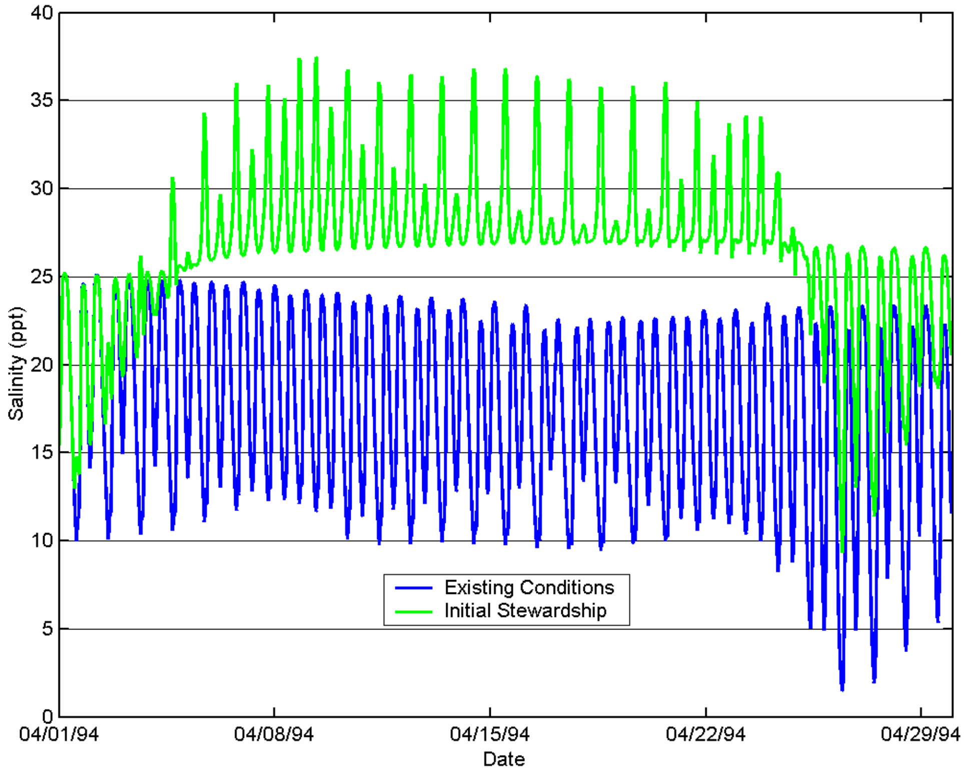
Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.





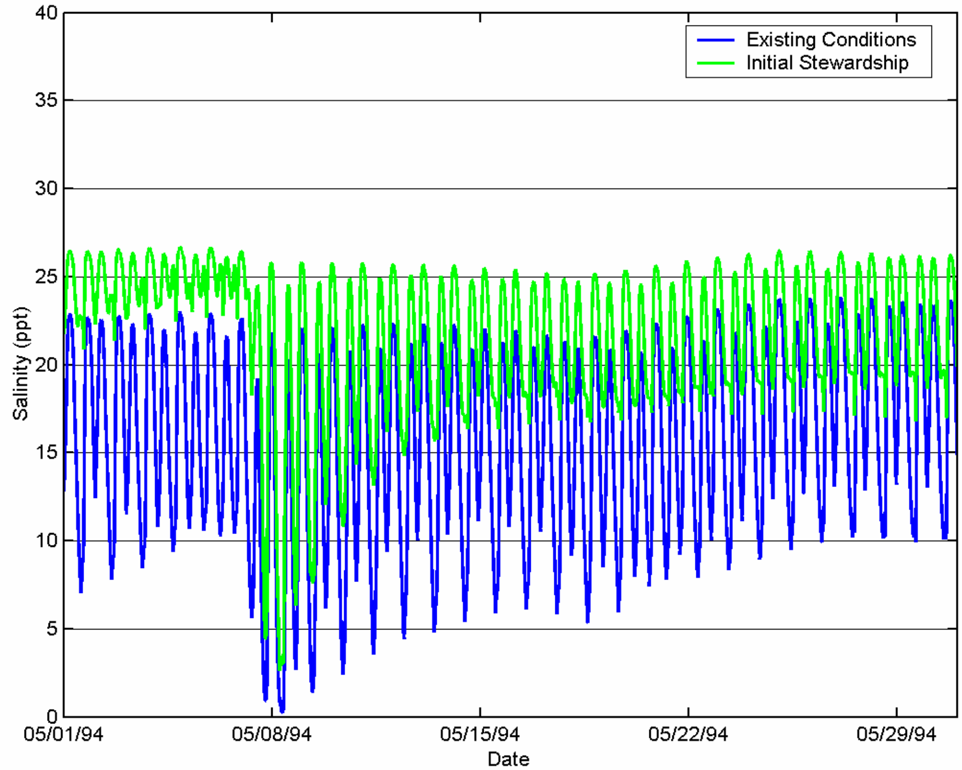
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 110. Predicted Salinity in Alviso Slough at the end of the Eighth Week of the Initial Release Period (Commencing April 1). Comparison of Longitudinal Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".



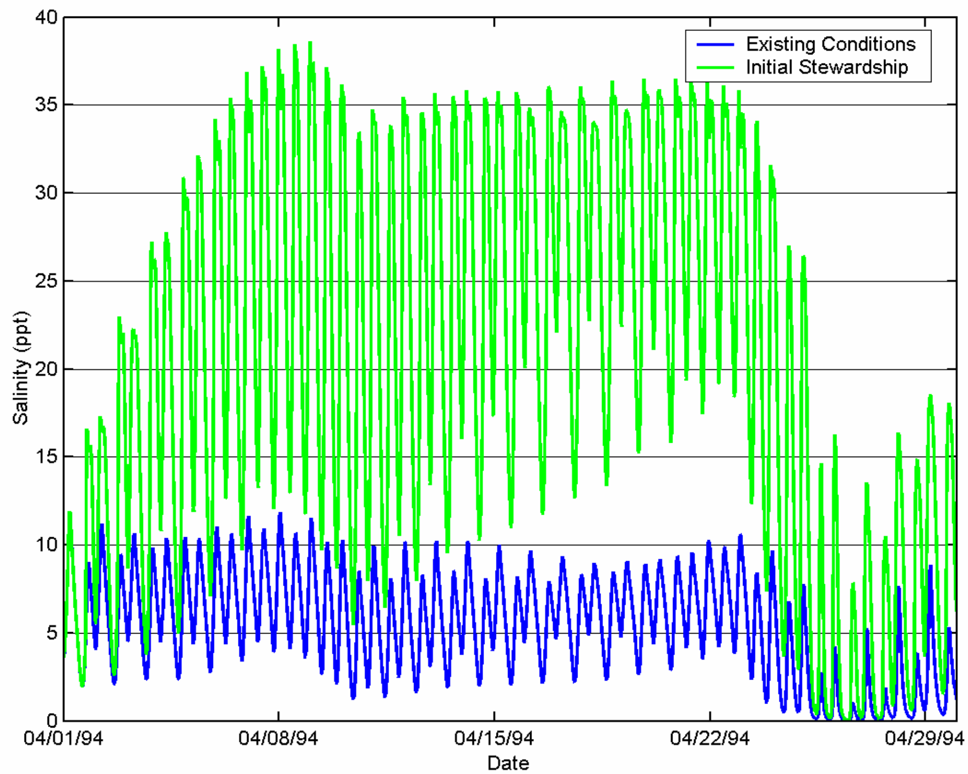
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 111. Predicted Salinity in Alviso Slough during the First Month of the Initial Release Period (Commencing April 1) at a Station 1 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values”.



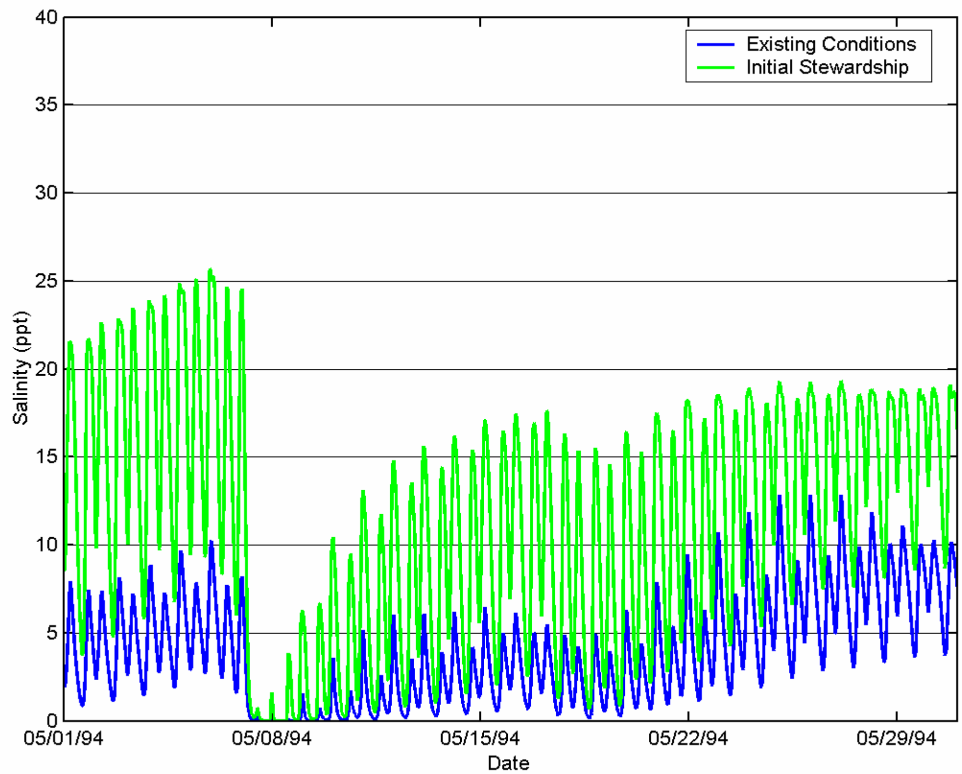
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 112. Predicted Salinity in Alviso Slough during the Second Month of the Initial Release Period (Commencing April 1) at a Station 1 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".



Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 113. Predicted Salinity in Alviso Slough during the First Month of the Initial Release Period (Commencing April 1) at a Station 5 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".

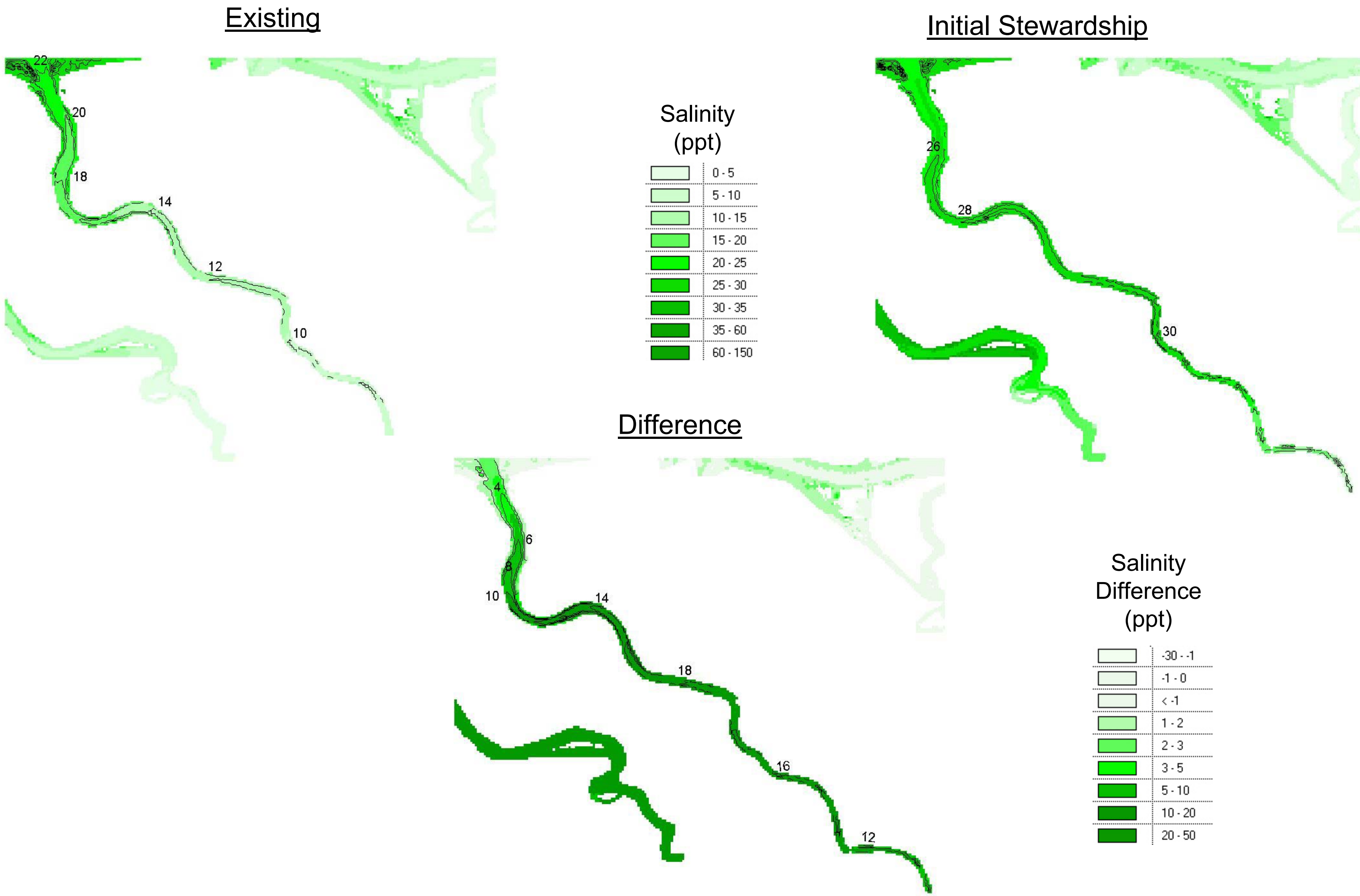


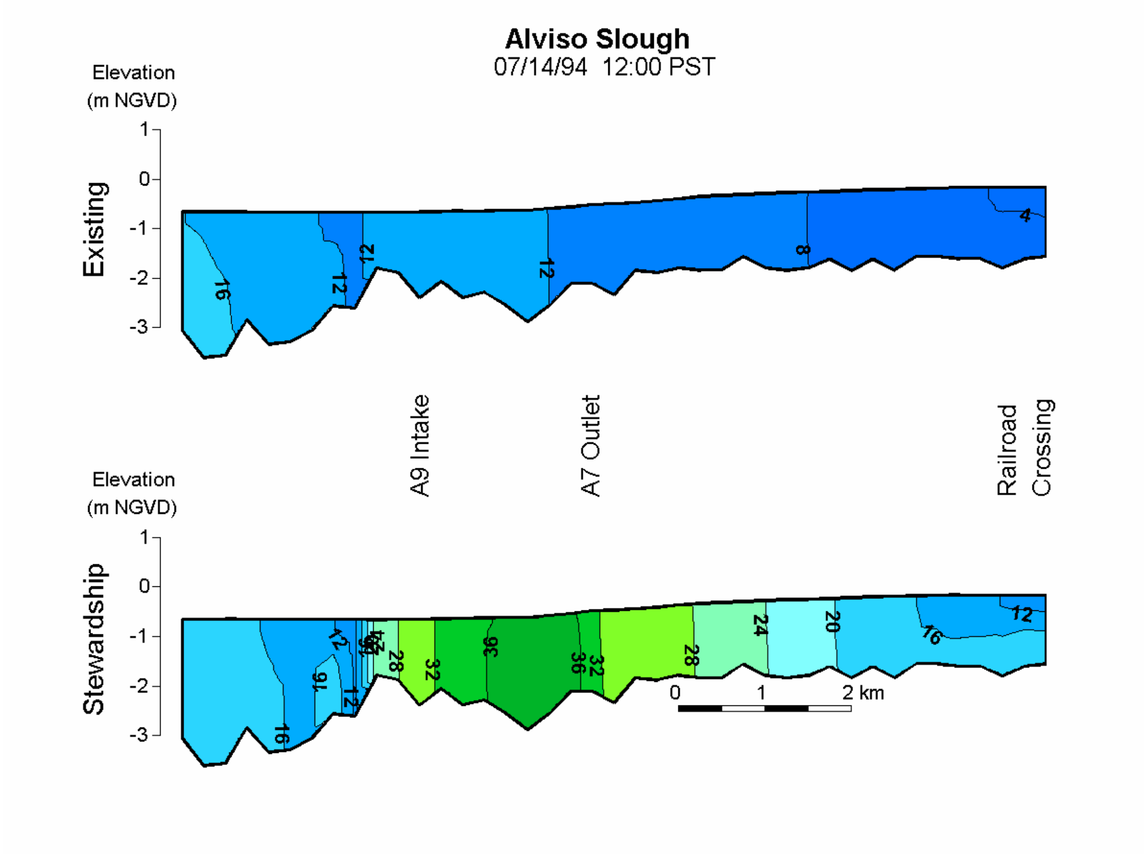
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 114. Predicted Salinity in Alviso Slough during the Second Month of the Initial Release Period (Commencing April 1) at a Station 5 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values”.

Figure 115. Predicted Salinity in Alviso Slough during **Phased Initial Release Period** after **2 Weeks** of Discharge
(assumes Initial Release Commences **July 1** at **Proposed Maximum Salinity Values**)

Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.



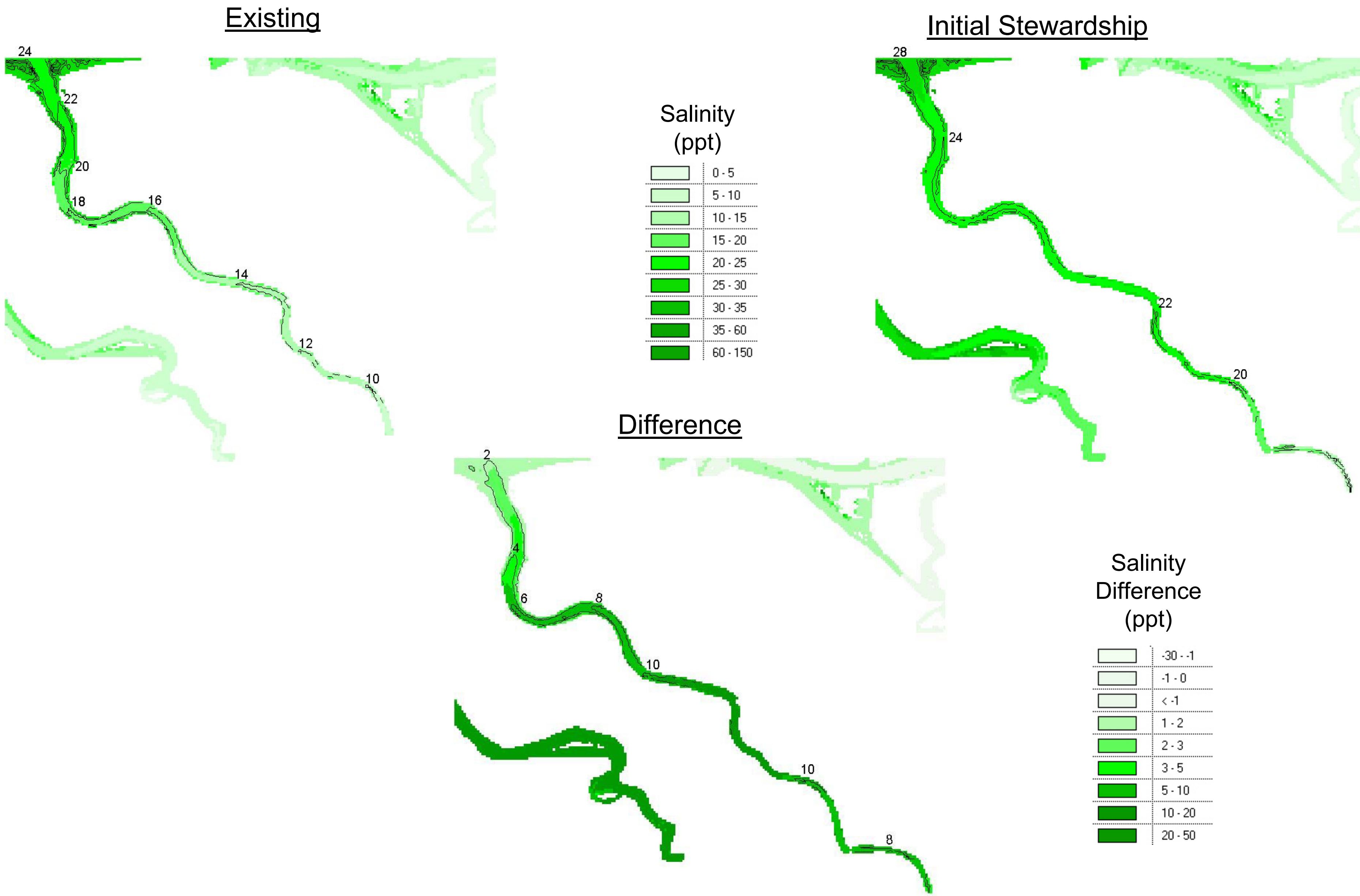


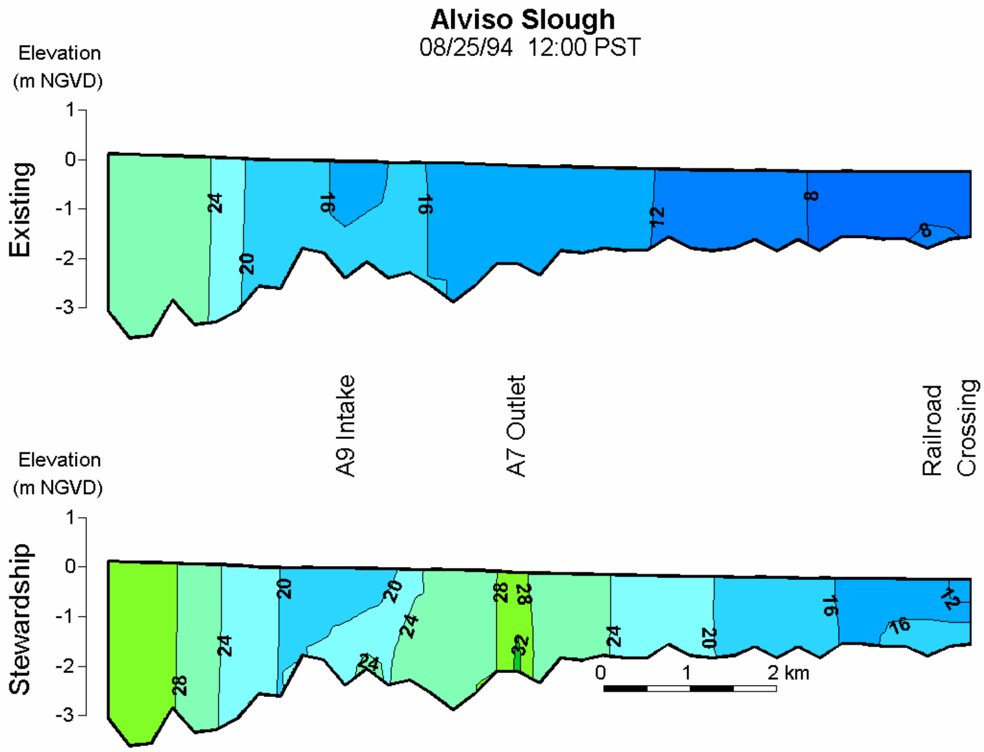
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 116. Predicted Salinity in Alviso Slough at the end of the Second Week of the Phased Initial Release Period (Commencing July 1). Comparison of Longitudinal Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values”.

Figure 117. Predicted Salinity in Alviso Slough during **Phased Initial Release Period** after **8 Weeks** of Discharge
(assumes Initial Release Commences **July 1** at **Proposed Maximum Salinity Values**)

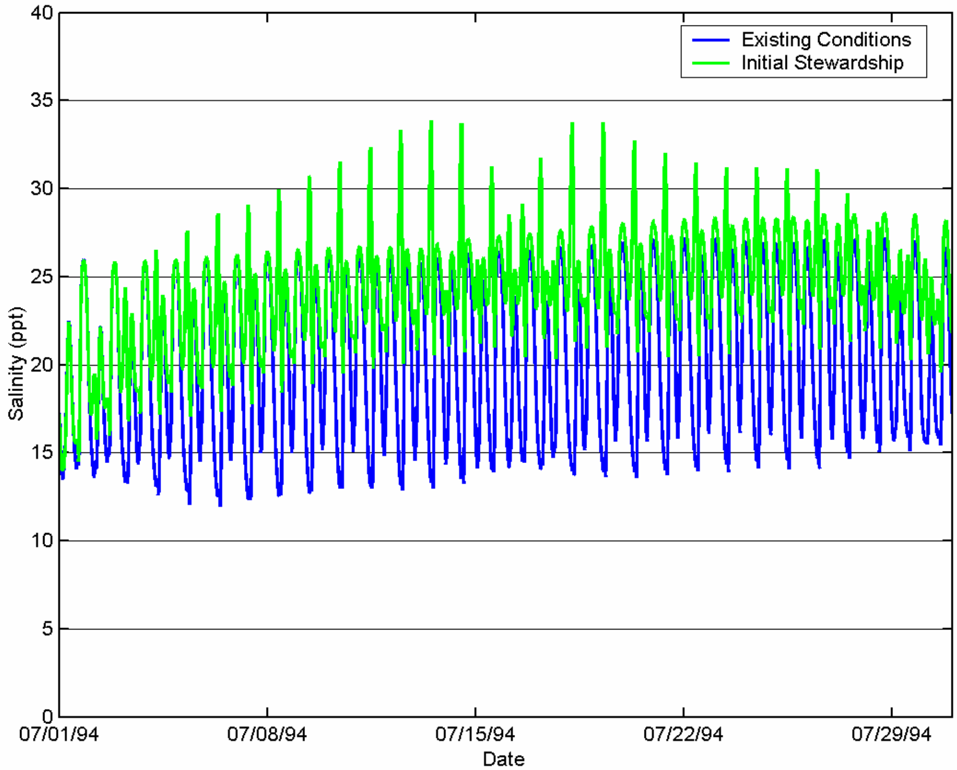
Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.





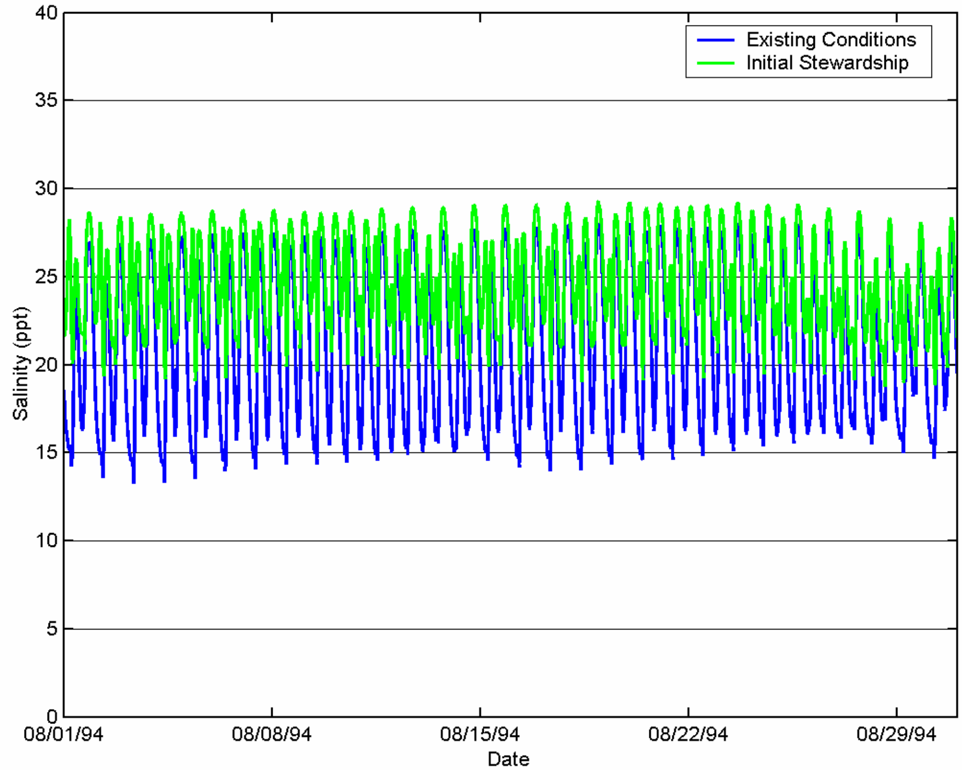
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 118. Predicted Salinity in Alviso Slough at the end of the Eighth Week of the Phased Initial Release Period (Commencing July 1). Comparison of Longitudinal Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values”.



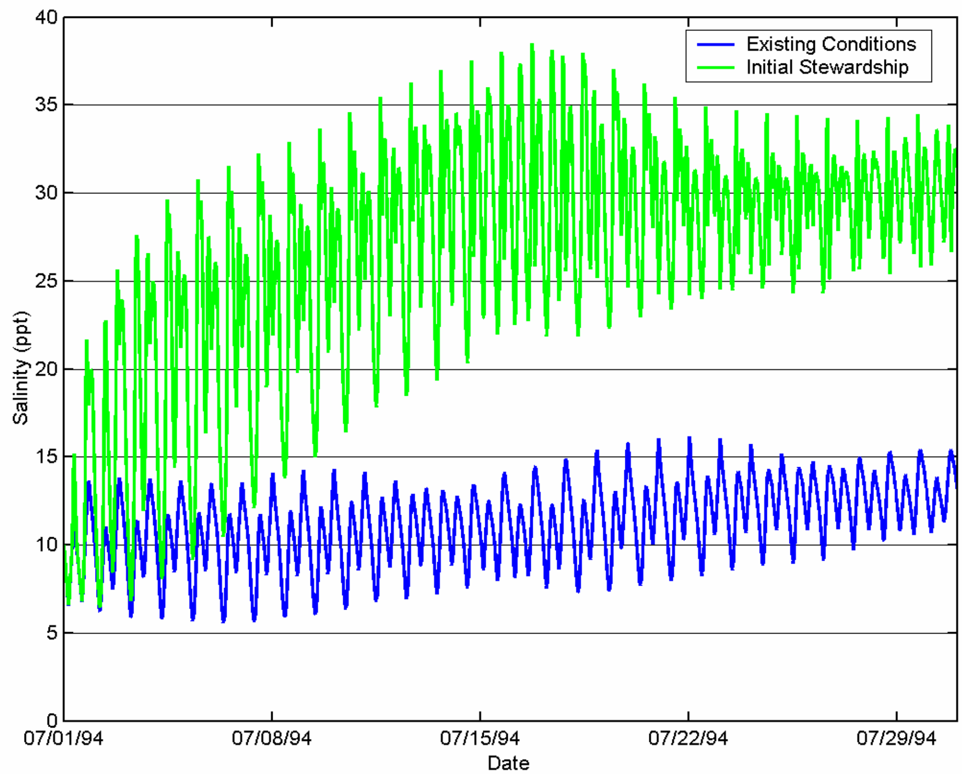
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 119. Predicted Salinity in Alviso Slough during the First Month of the Phased Initial Release Period (Commencing July 1) at a Station 1 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".



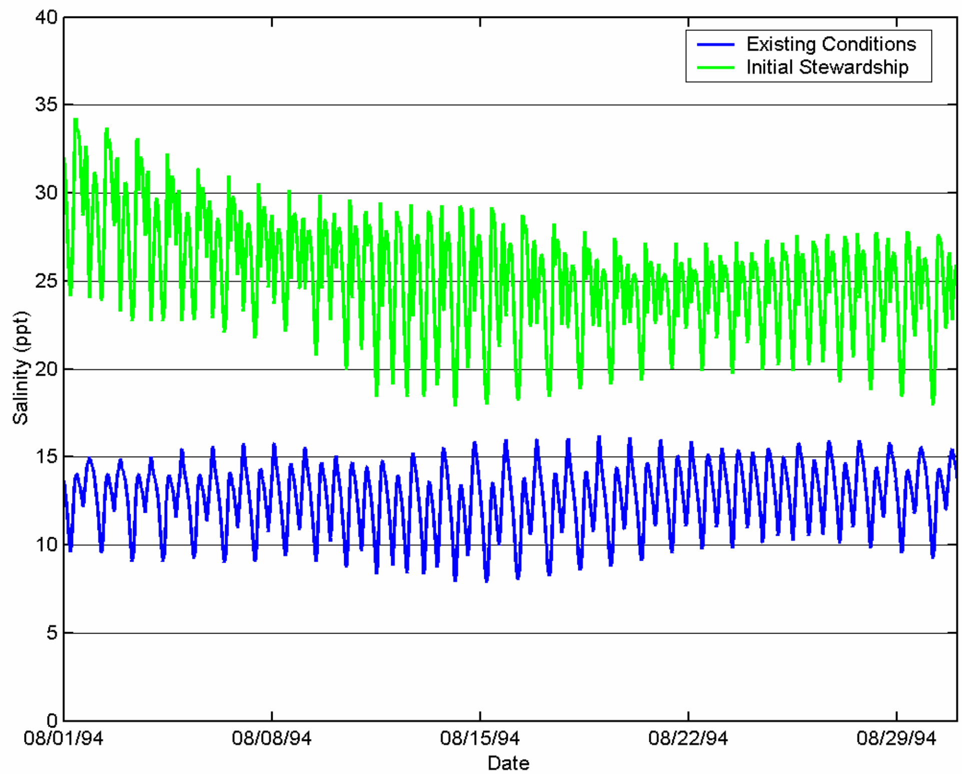
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 120. Predicted Salinity in Alviso Slough during the Second Month of the Phased Initial Release Period (Commencing July 1) at a Station 1 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".



Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 121. Predicted Salinity in Alviso Slough during the First Month of the Phased Initial Release Period (Commencing July 1) at a Station 5 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".

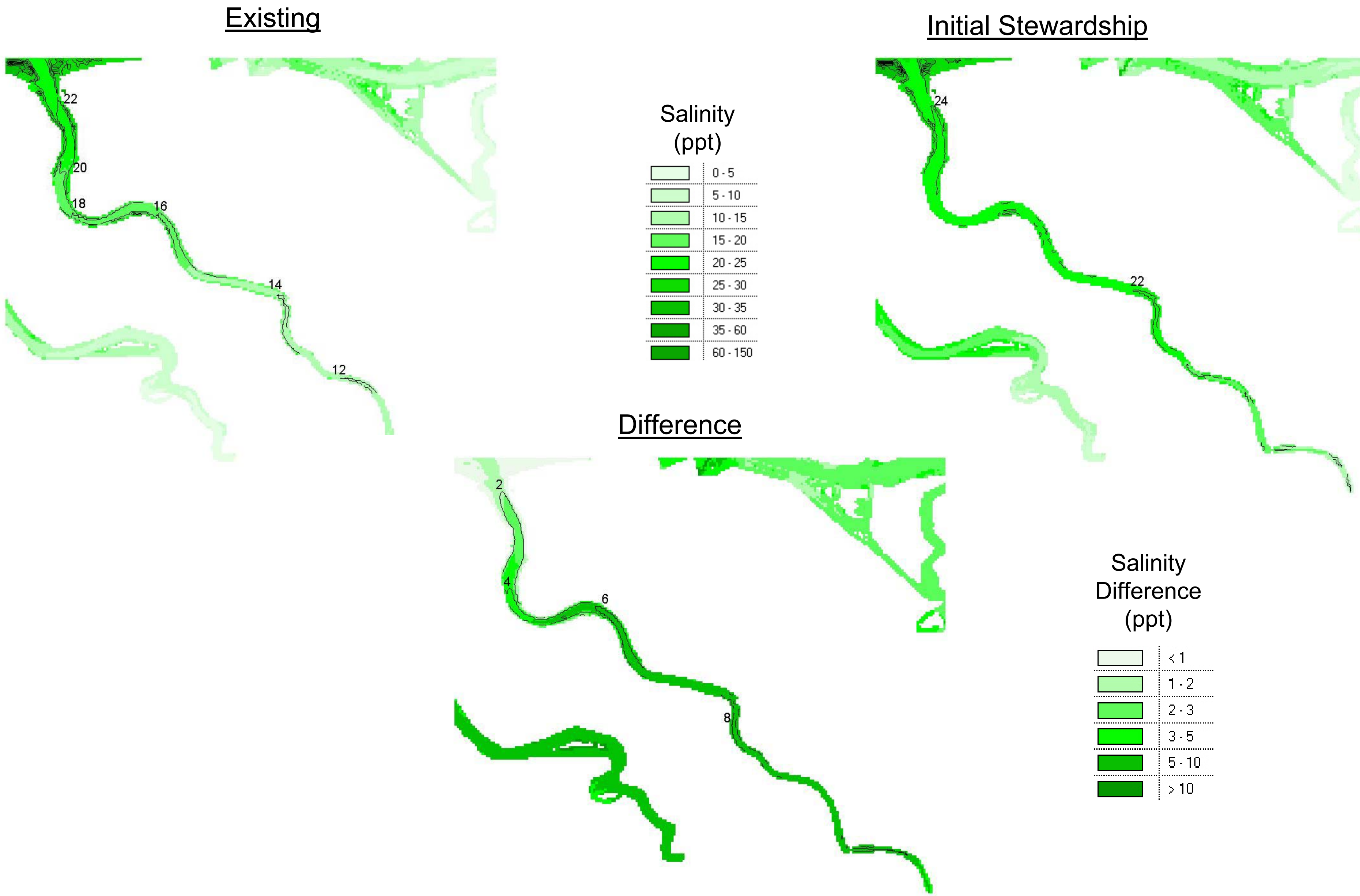


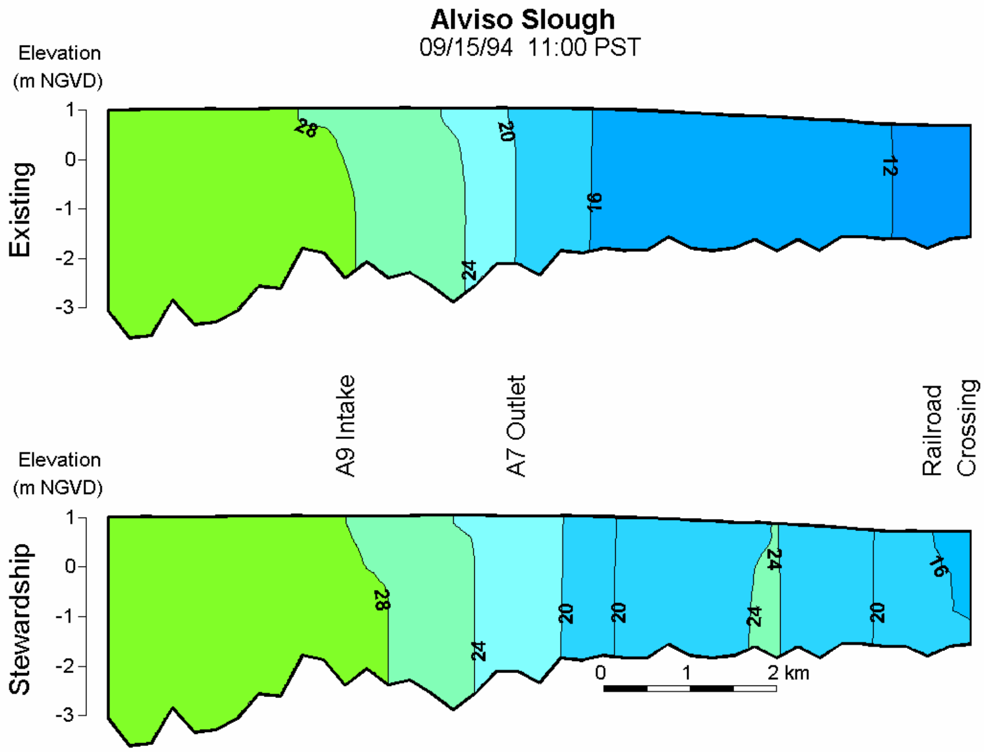
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 122. Predicted Salinity in Alviso Slough during the Second Month of the Phased Initial Release Period (Commencing July 1) at a Station 5 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".

Figure 123. Predicted Salinity in Alviso Slough during **Continuous Circulation Period** in **Late Summer**
(based on 9/15/94 conditions and assumes Initial Release has been completed)

Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.





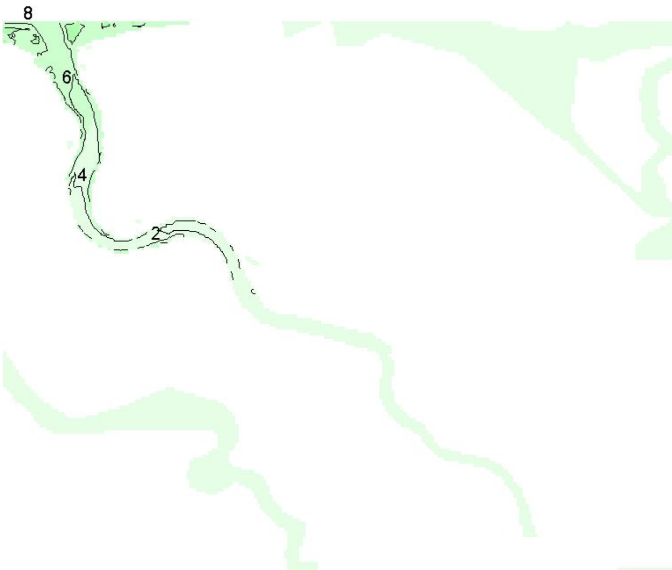
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994 and 1995 weather and tidal conditions.

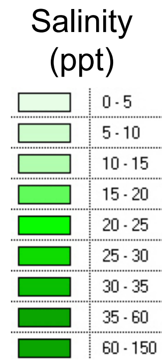
Figure 124. Predicted Salinity in Alviso Slough in mid-September during the Continuous Circulation Period. Comparison of Longitudinal Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Continuous Circulation Salinity Values".

Figure 125. Predicted Salinity in Alviso Slough during **Continuous Circulation Period** in **Winter Storm Event**
(based on 2/20/95 conditions and assumes Initial Release has been completed)

Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.

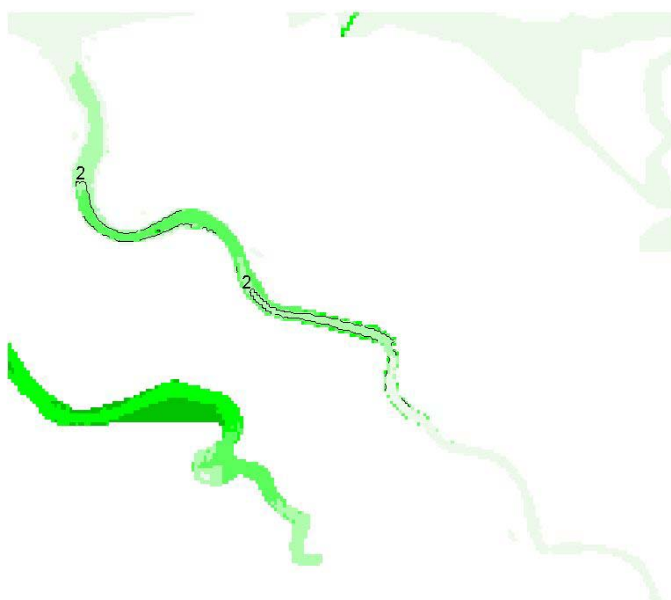
Existing





Initial Stewardship

Difference



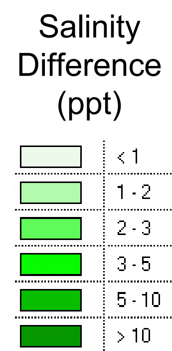
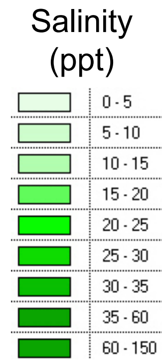


Figure 126. Predicted Salinity in Alviso Slough during **Continuous Circulation Period** in **Winter Dry Period**
(based on 3/10/95 conditions and assumes Initial Release has been completed)

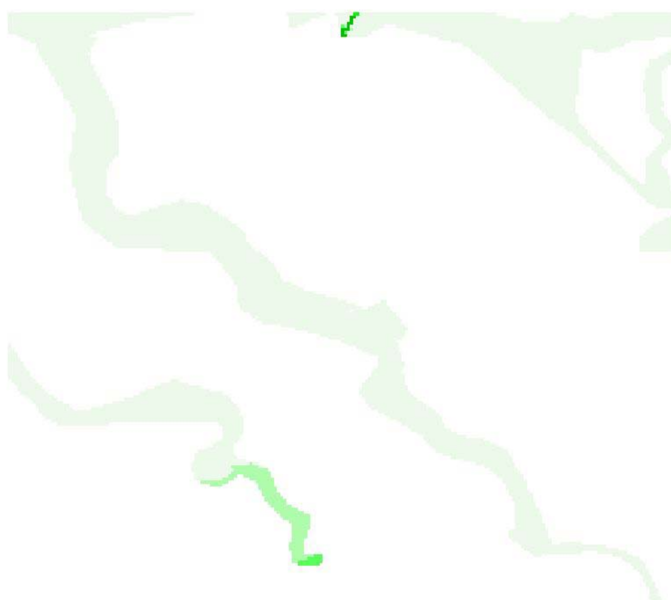
Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.

Existing



Initial Stewardship

Difference



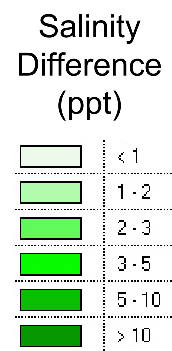
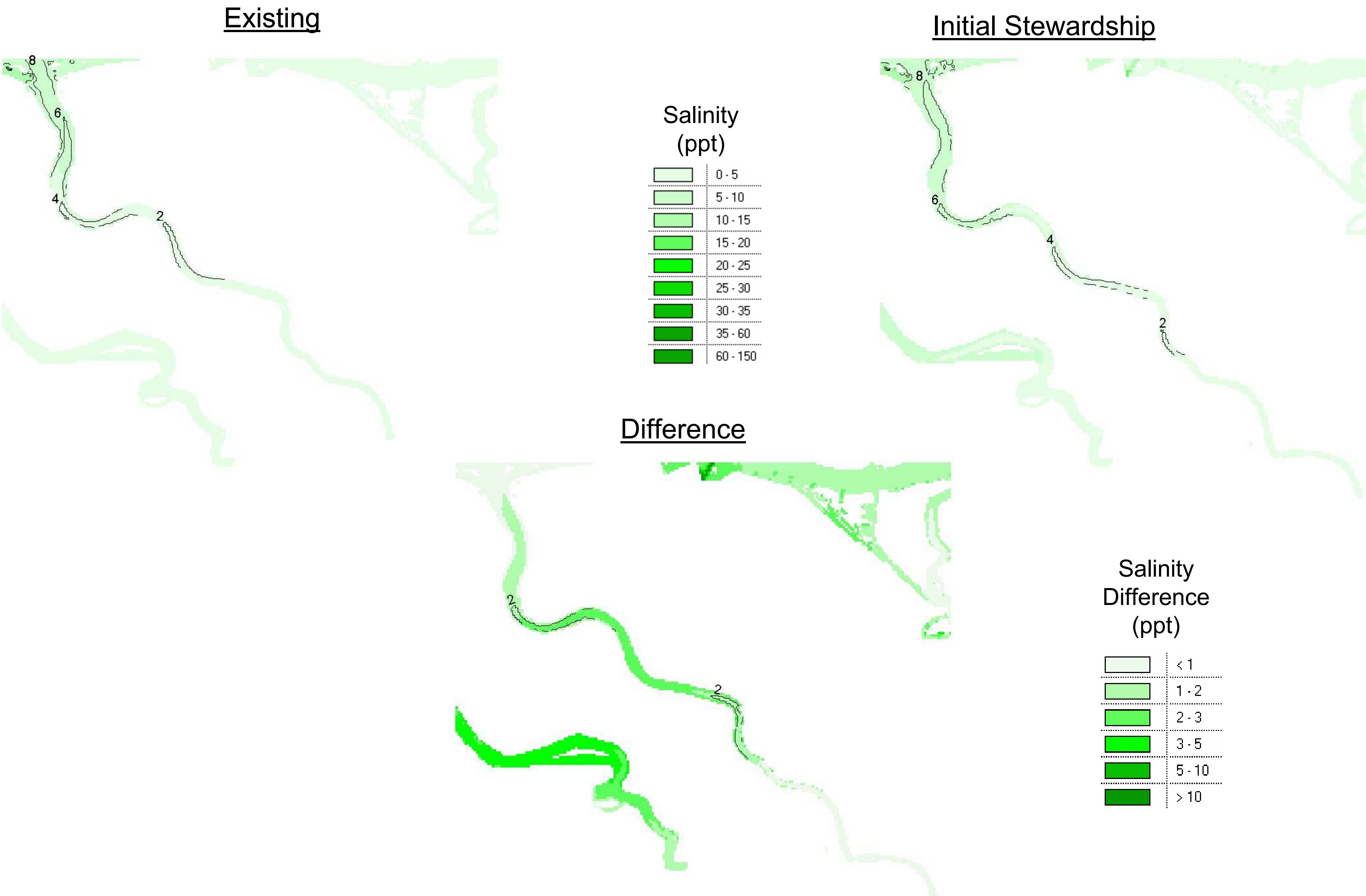


Figure 127. Predicted Salinity in Alviso Slough during **Continuous Circulation Period** in **Late Spring**
(based on 6/1/95 conditions and assumes Initial Release has been completed)

Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.



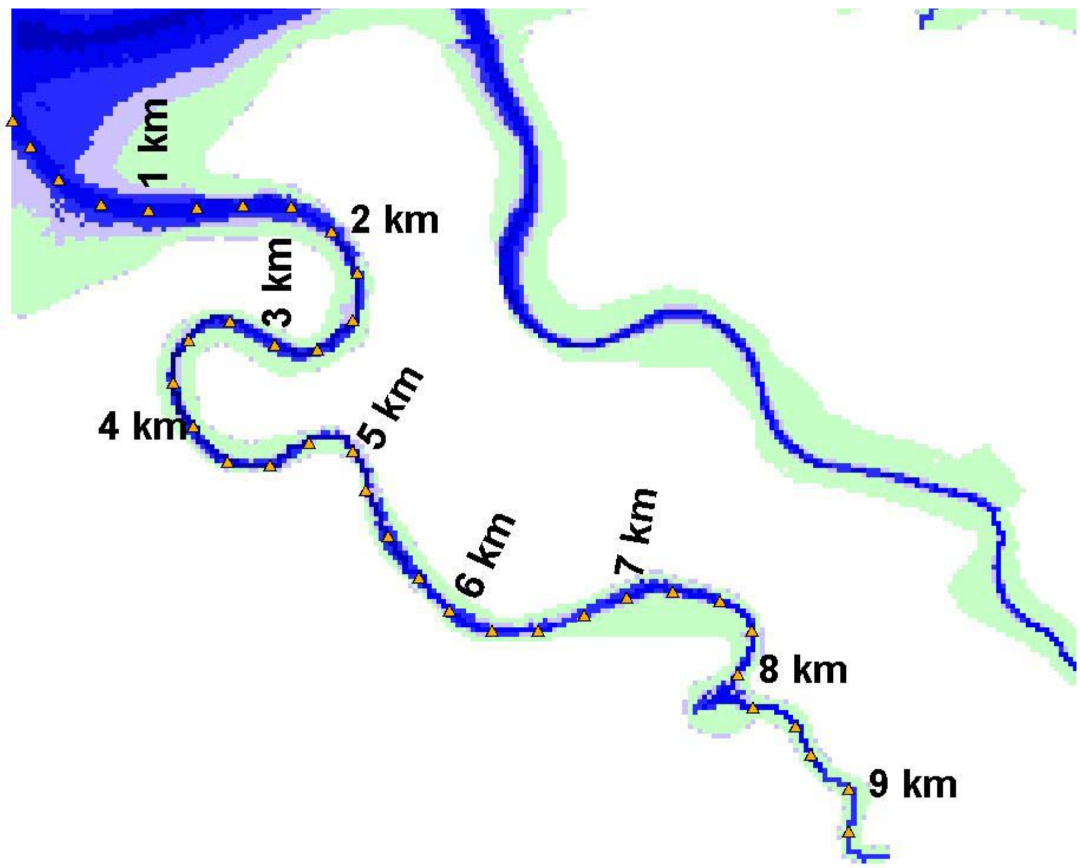
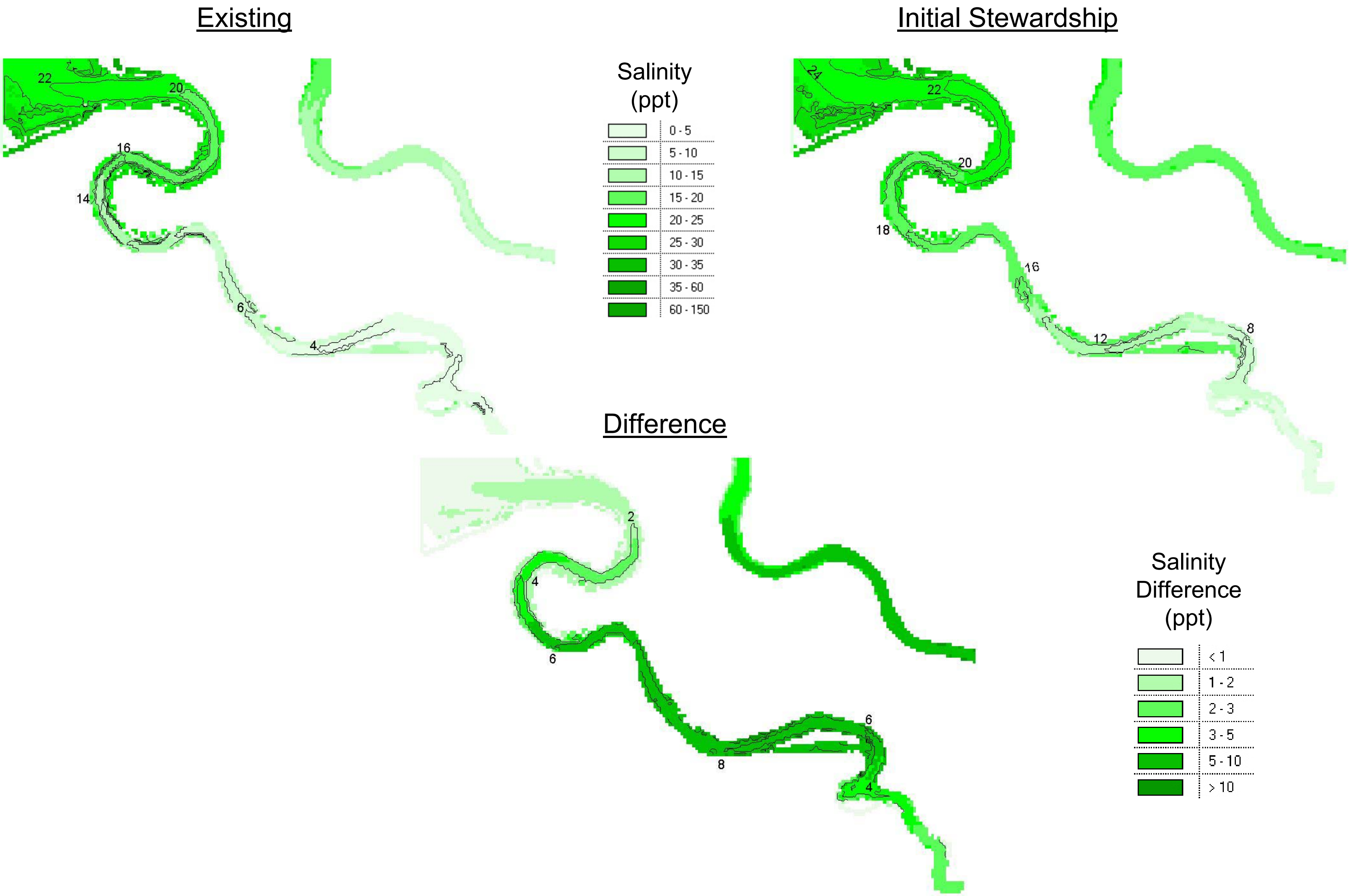
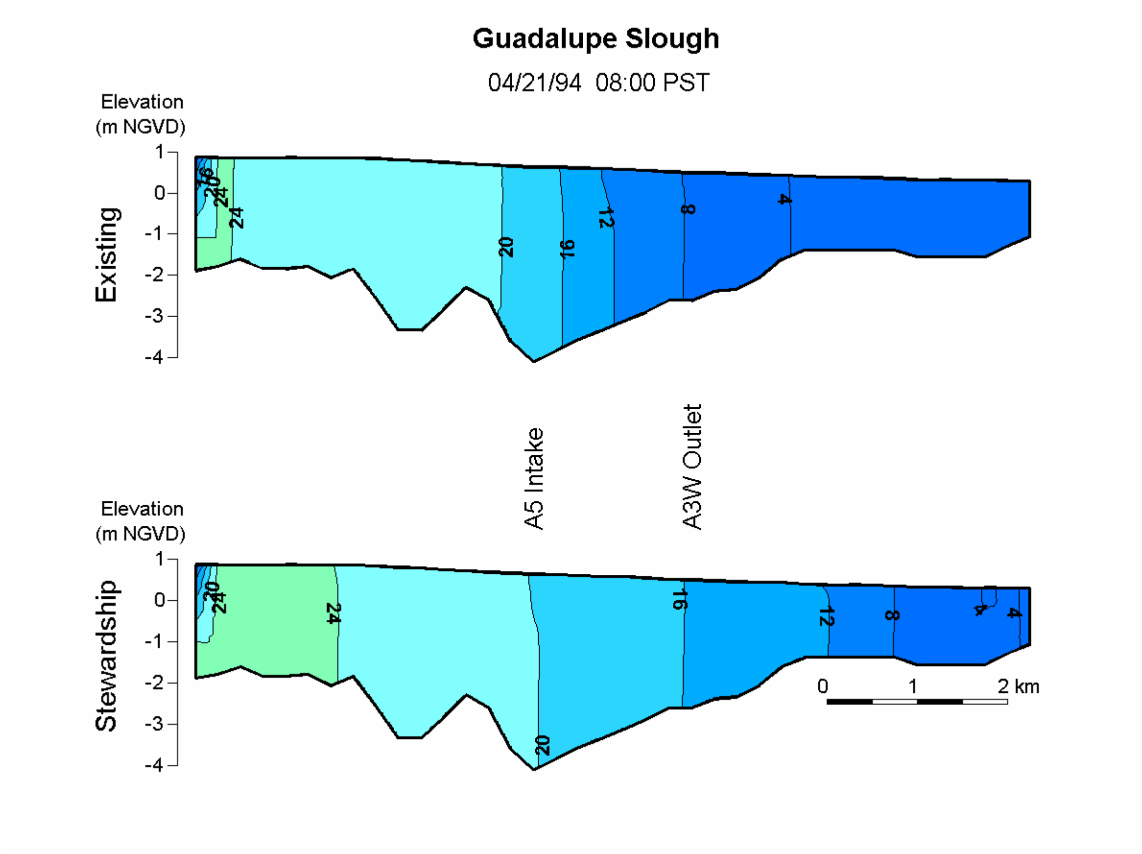


Figure 128. Distances along Guadalupe Slough – starting at its mouth and moving upstream.

Figure 129. Predicted Salinity in Guadalupe Slough during **Initial Release Period** after **3 Weeks** of Discharge
(assumes Initial Release Commences **April1** at **2002 Salinity Values**)

Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.



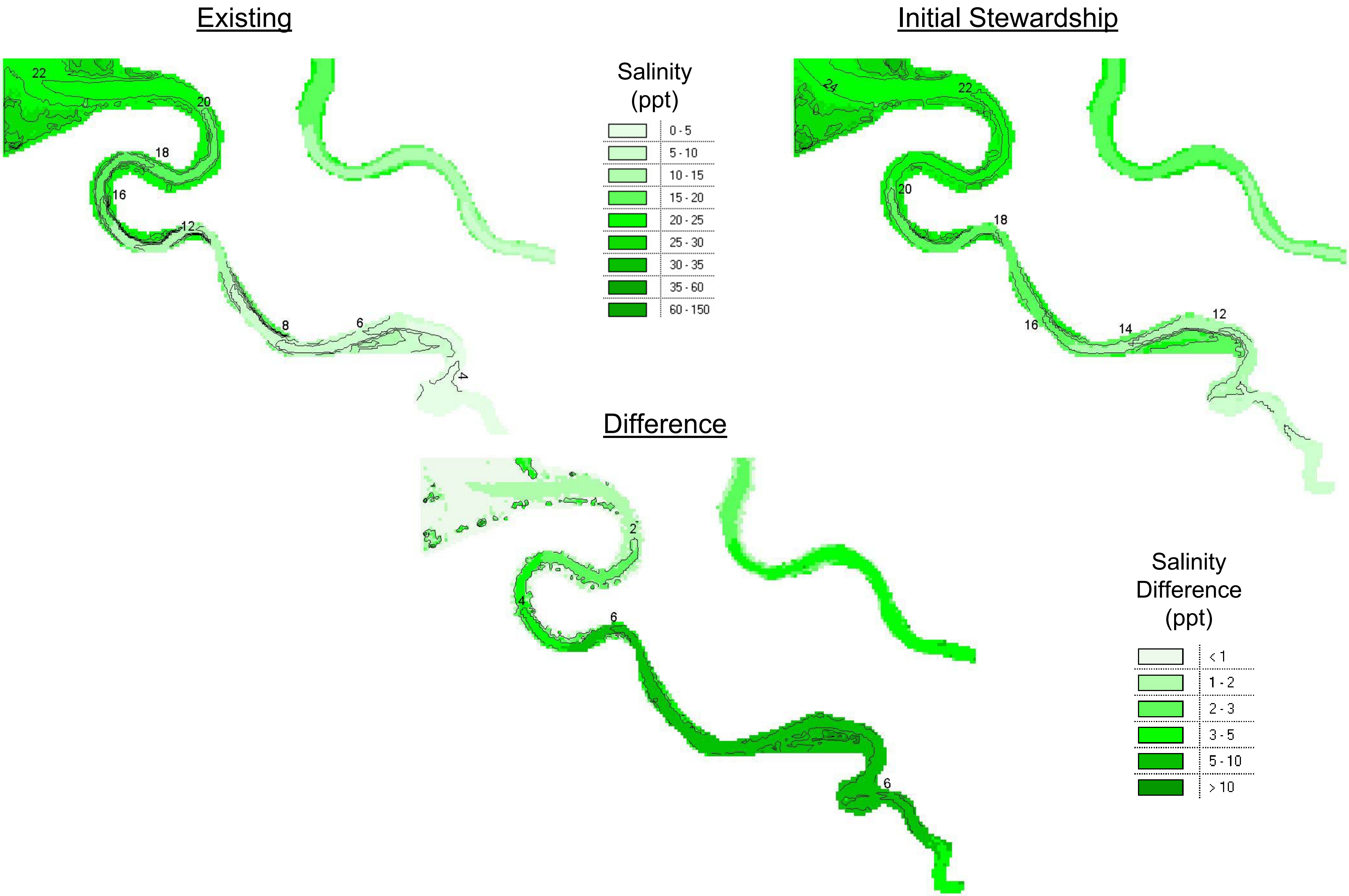


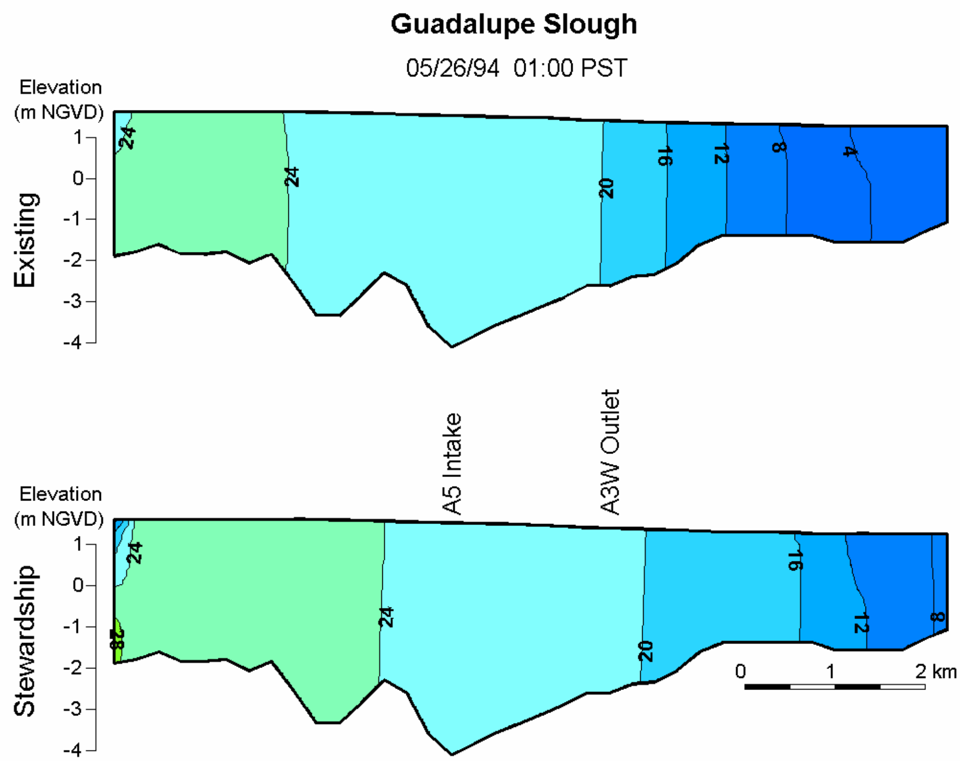
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 130. Predicted Salinity in Guadalupe Slough at the end of the Third Week of the Initial Release Period (Commencing April 1). Comparison of Longitudinal Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at 2002 Salinity Values".

Figure 131. Predicted Salinity in Guadalupe Slough during **Initial Release Period** after **8 Weeks** of Discharge
(assumes Initial Release Commences **April1** at **2002 Salinity Values**)

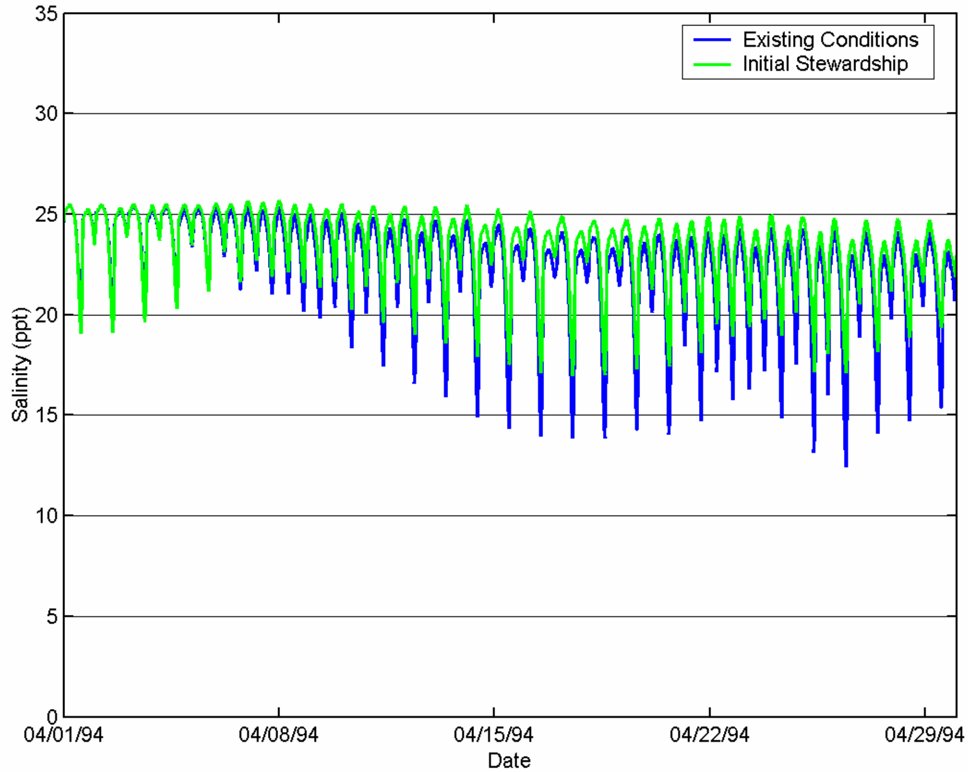
Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.





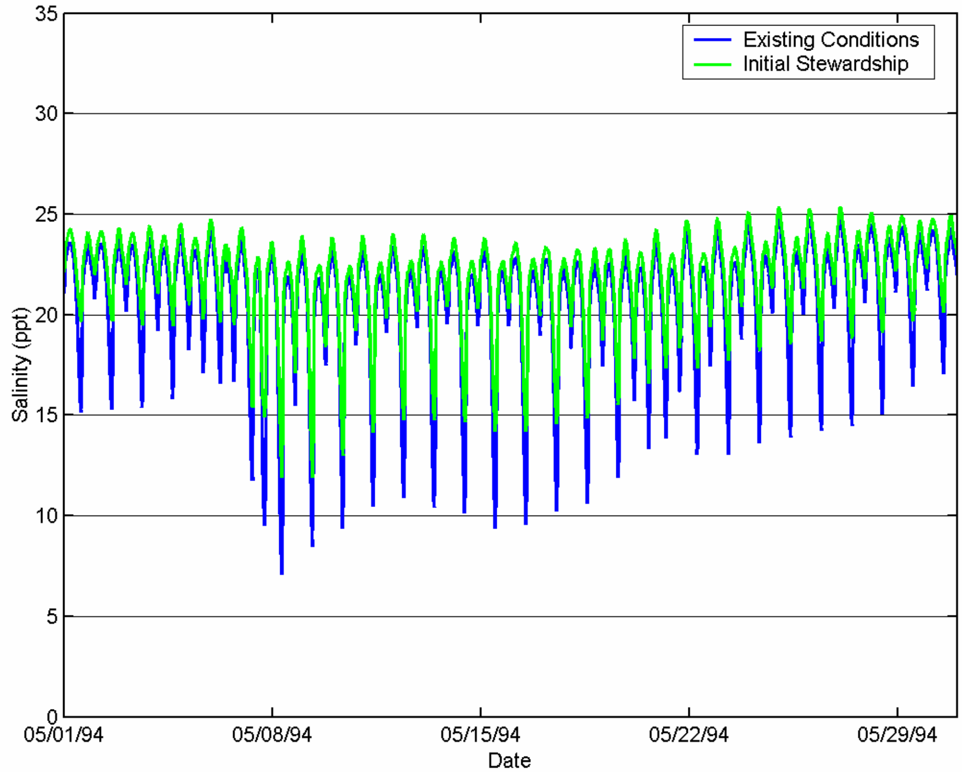
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 132. Predicted Salinity in Guadalupe Slough at the end of the Eighth Week of the Initial Release Period (Commencing April 1). Comparison of Longitudinal Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at 2002 Salinity Values".



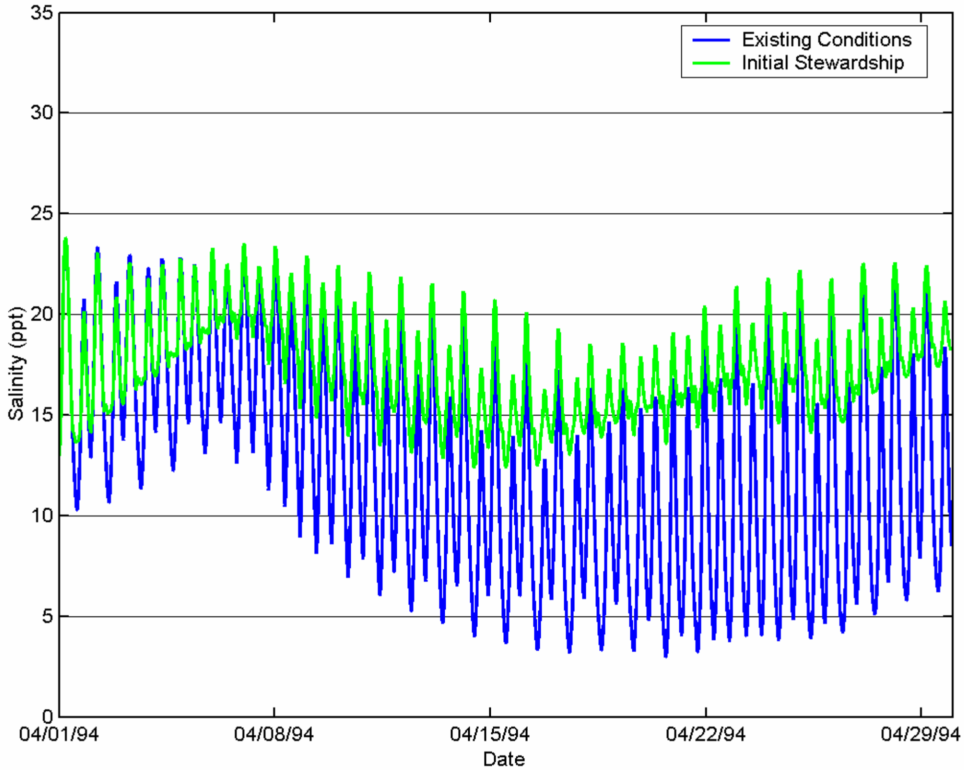
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 133. Predicted Salinity in Guadalupe Slough during the First Month of the Initial Release Period (Commencing April 1) at a Station 1 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at 2002 Salinity Values”.



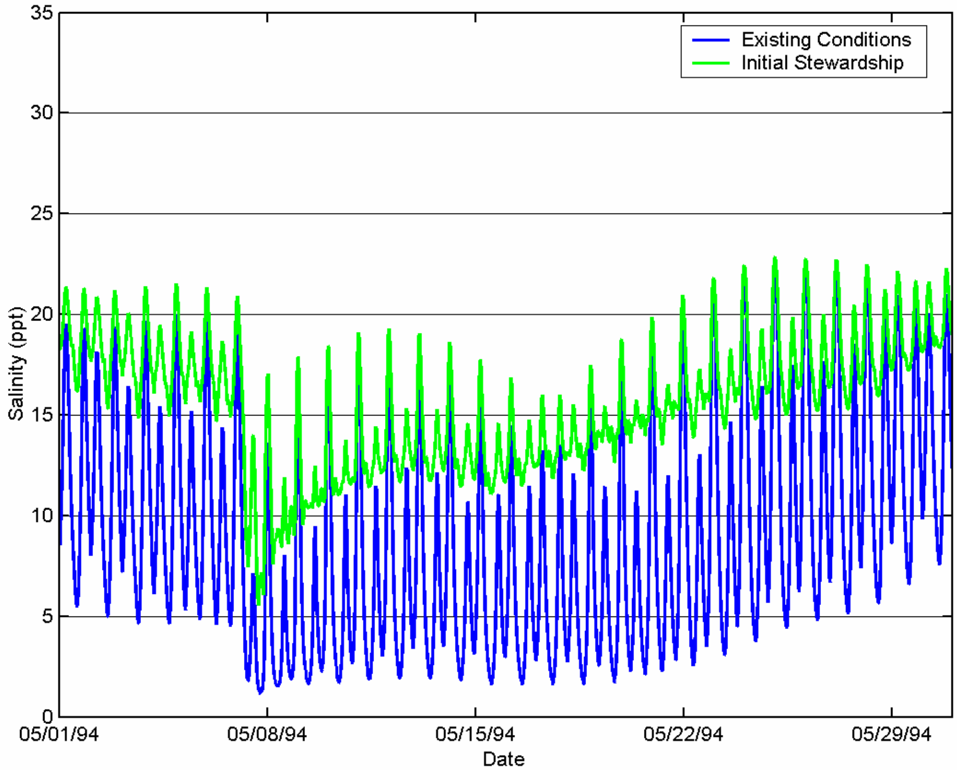
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 134. Predicted Salinity in Guadalupe Slough during the Second Month of the Initial Release Period (Commencing April 1) at a Station 1 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at 2002 Salinity Values”.



Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 135. Predicted Salinity in Guadalupe Slough during the First Month of the Initial Release Period (Commencing April 1) at a Station 5 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at 2002 Salinity Values".



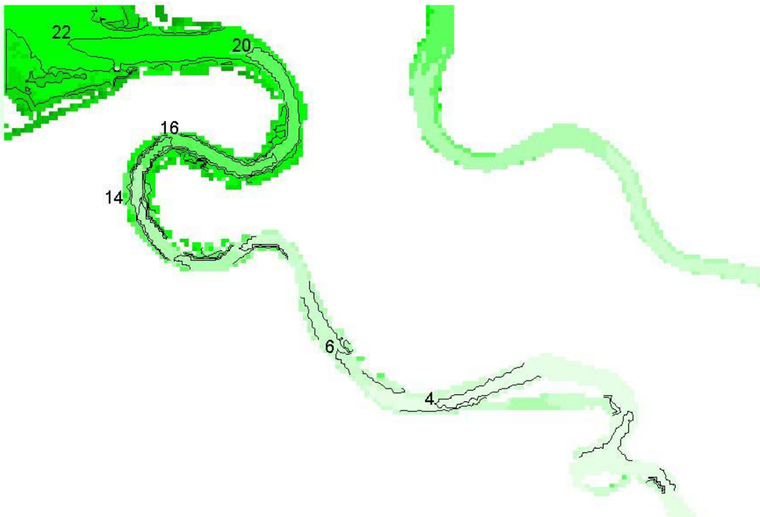
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

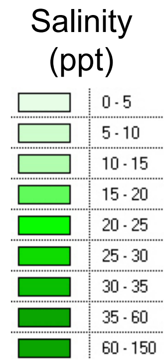
Figure 136. Predicted Salinity in Guadalupe Slough during the Second Month of the Initial Release Period (Commencing April 1) at a Station 5 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at 2002 Salinity Values”.

Figure 137. Predicted Salinity in Guadalupe Slough during **Initial Release Period** after **3 Weeks** of Discharge
(assumes Initial Release Commences **April1** at **Proposed Maximum Salinity Values**)

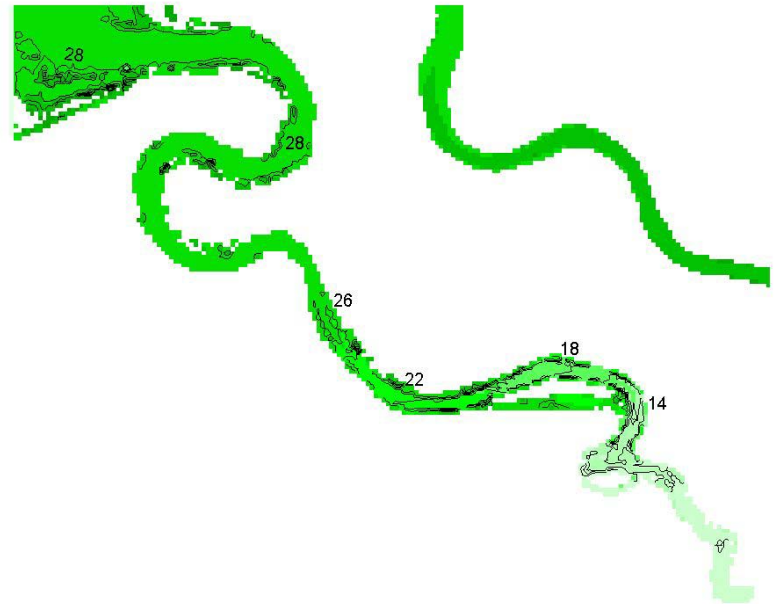
Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.

Existing

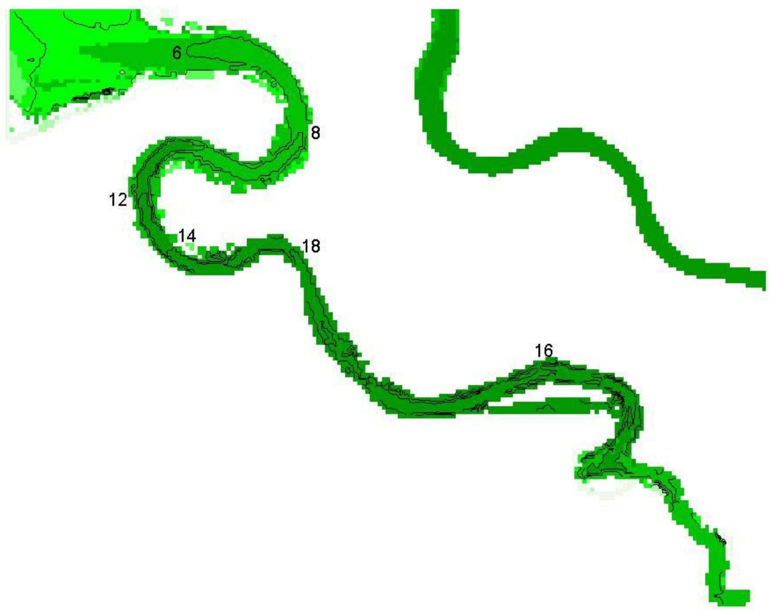


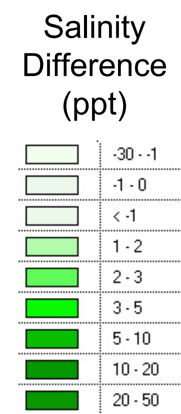


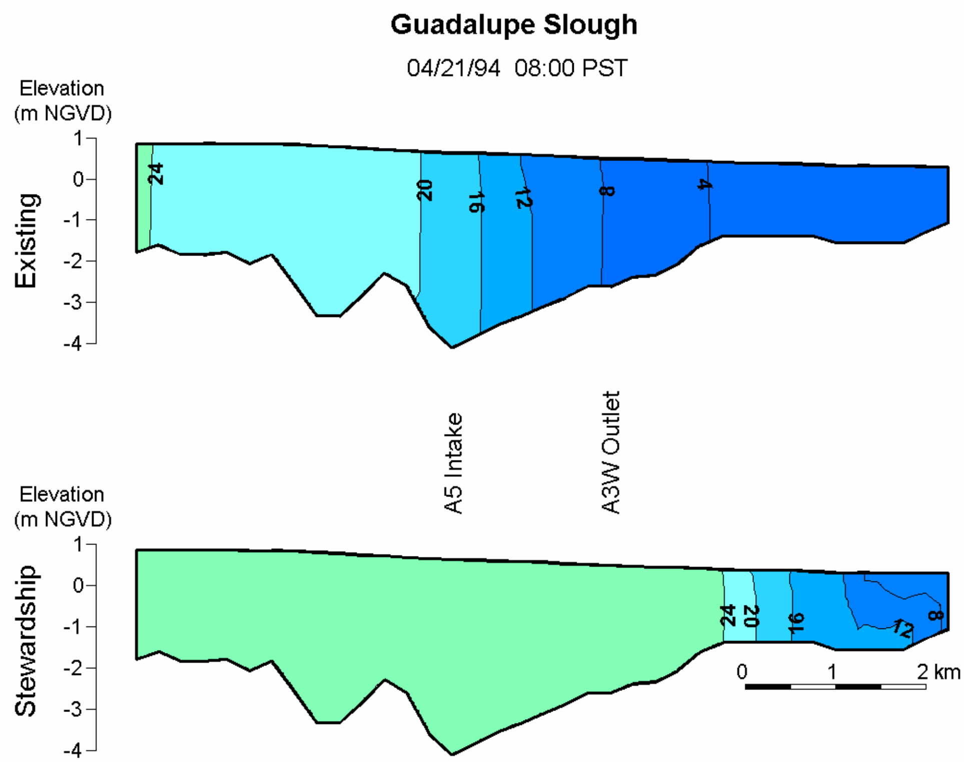
Initial Stewardship



Difference





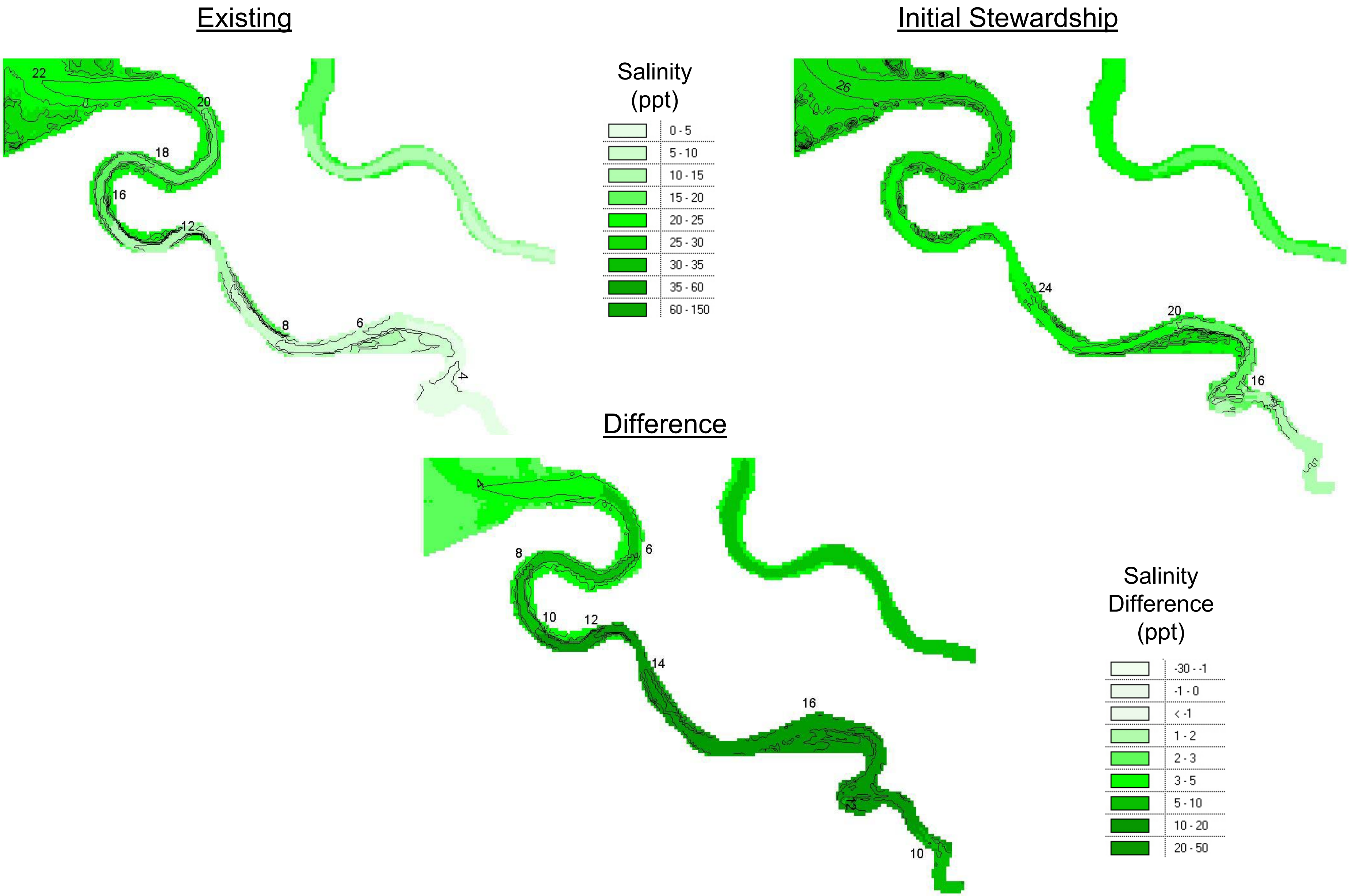


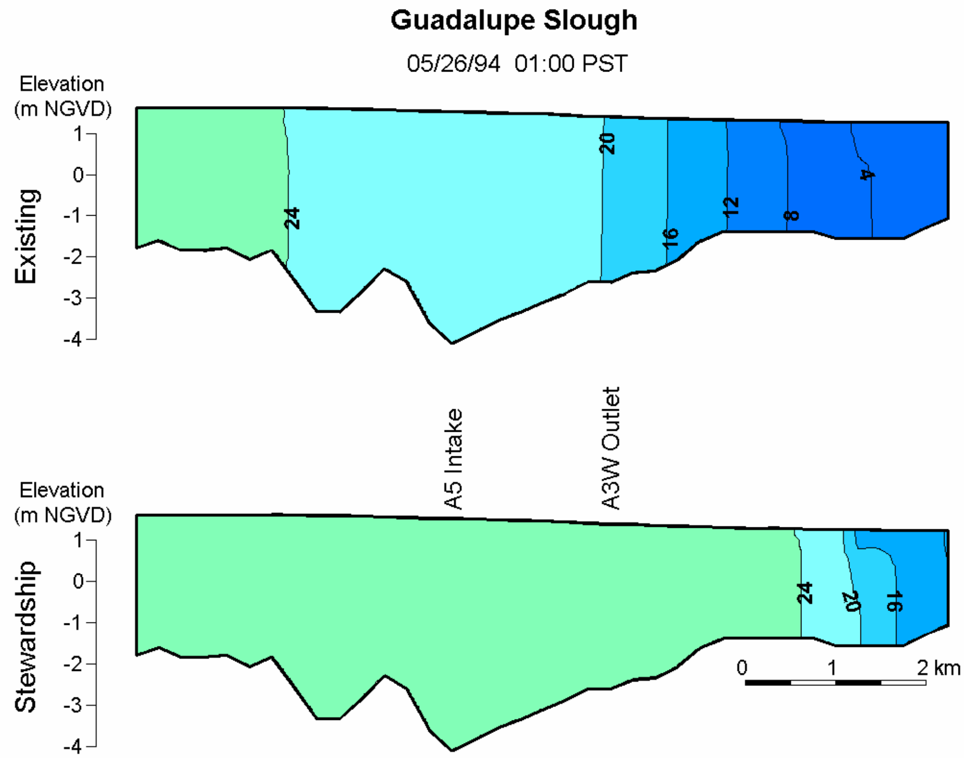
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 138. Predicted Salinity in Guadalupe Slough at the end of the Third Week of the Initial Release Period (Commencing April 1). Comparison of Longitudinal Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".

Figure 139. Predicted Salinity in Guadalupe Slough during **Initial Release Period** after **8 Weeks** of Discharge
(assumes Initial Release Commences **April1** at **Proposed Maximum Salinity Values**)

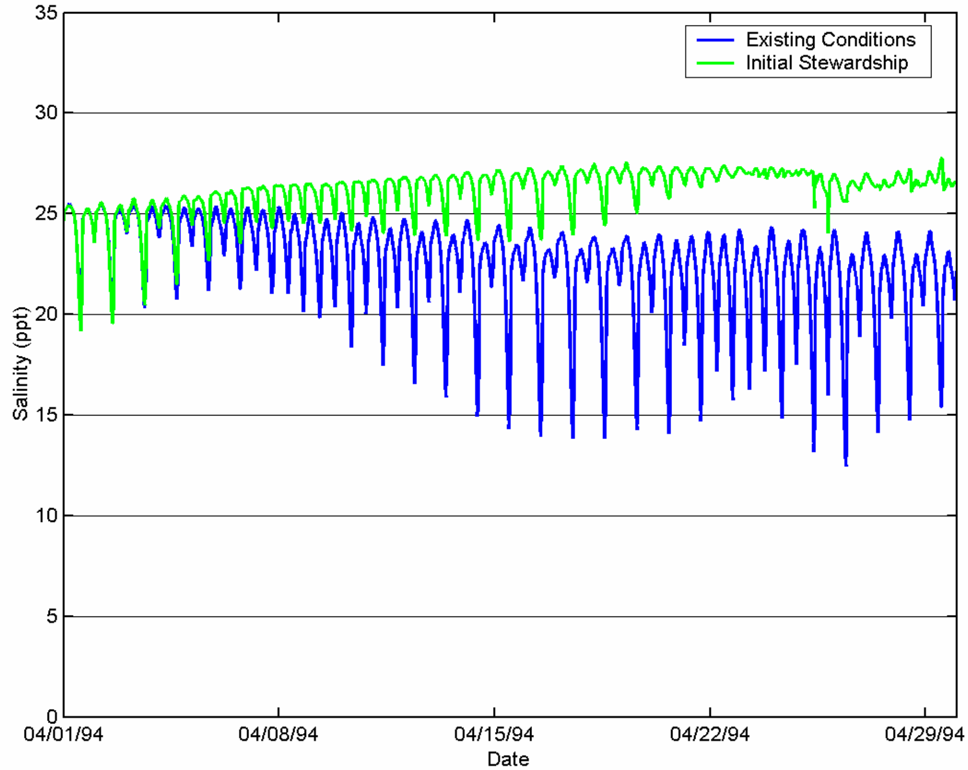
Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.





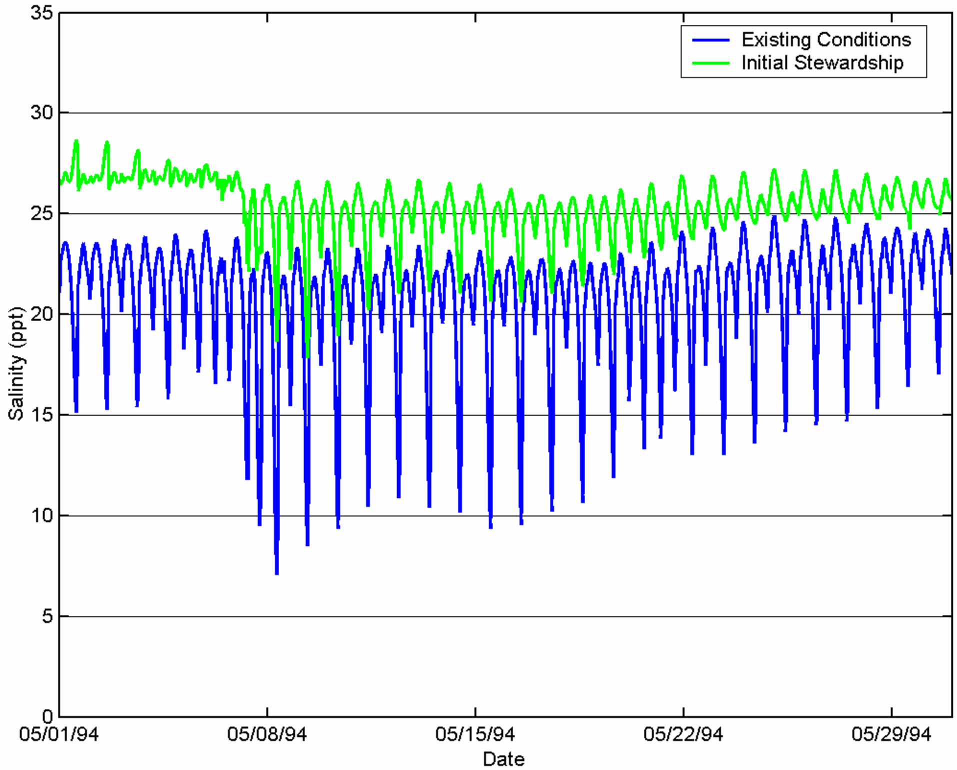
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 140. Predicted Salinity in Guadalupe Slough at the end of the Eighth Week of the Initial Release Period (Commencing April 1). Comparison of Longitudinal Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".



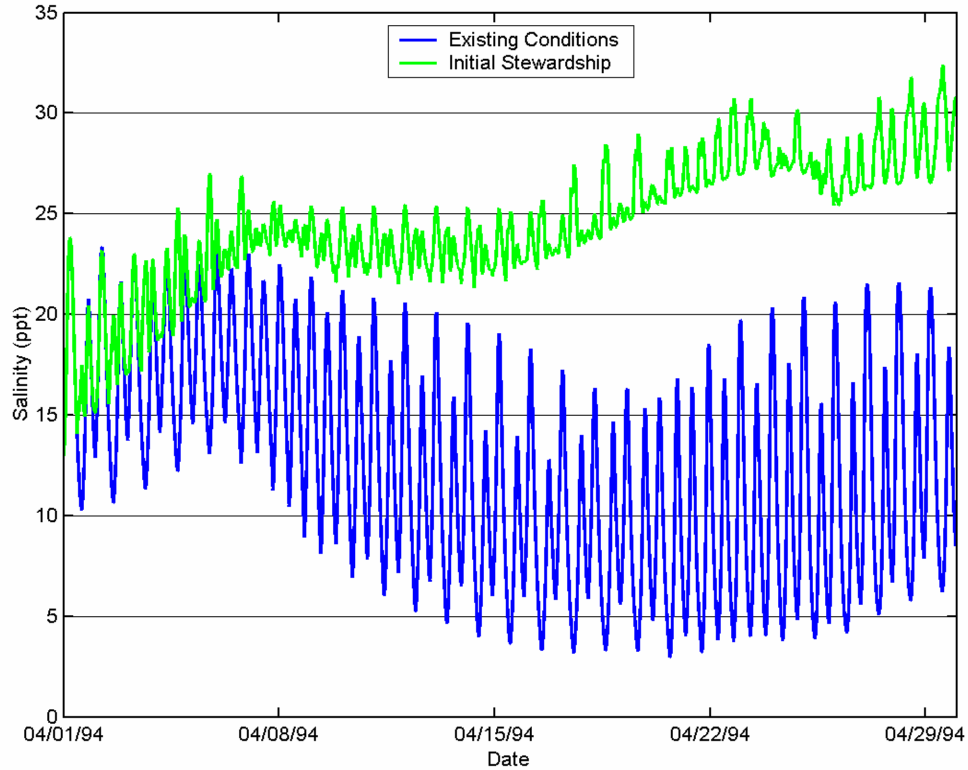
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 141. Predicted Salinity in Guadalupe Slough during the First Month of the Initial Release Period (Commencing April 1) at a Station 1 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values”.



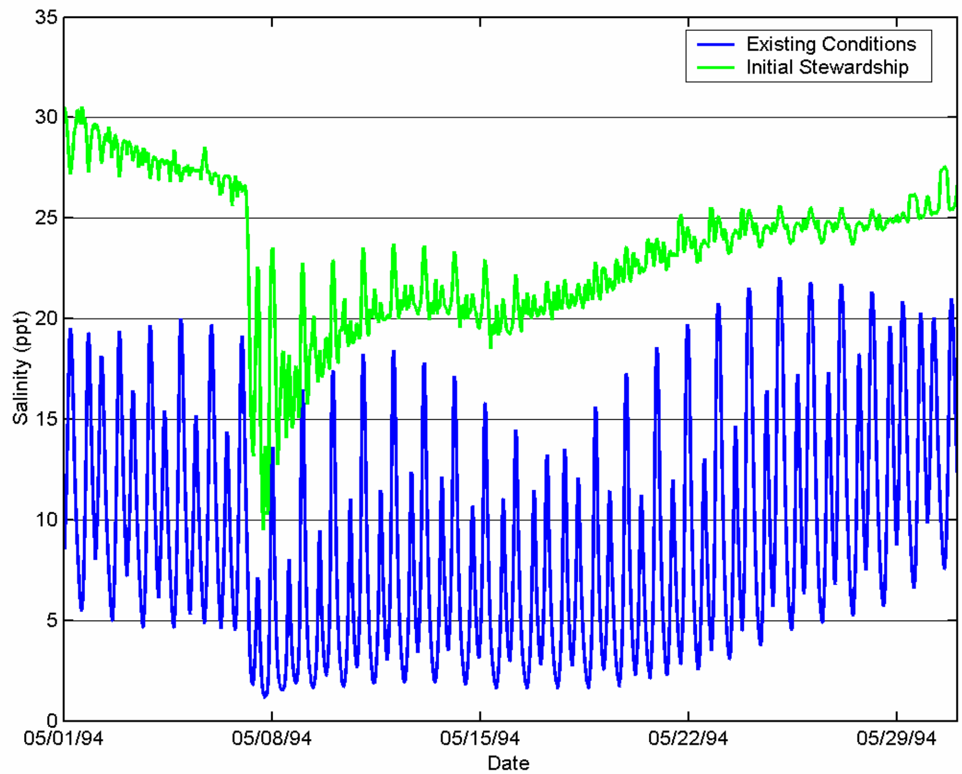
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 142. Predicted Salinity in Guadalupe Slough during the Second Month of the Initial Release Period (Commencing April 1) at a Station 1 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values”.



Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 143. Predicted Salinity in Guadalupe Slough during the First Month of the Initial Release Period (Commencing April 1) at a Station 5 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values”.

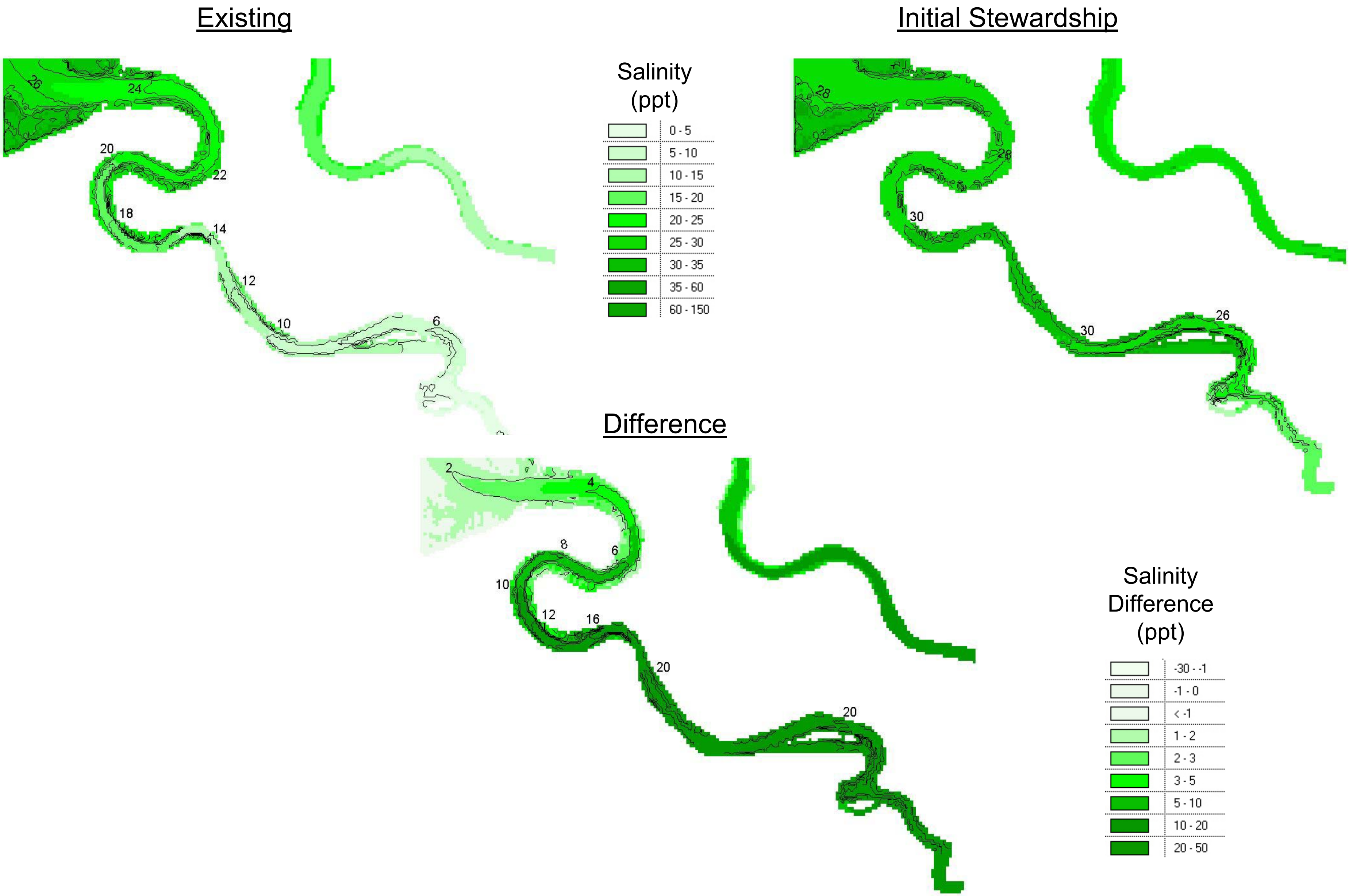


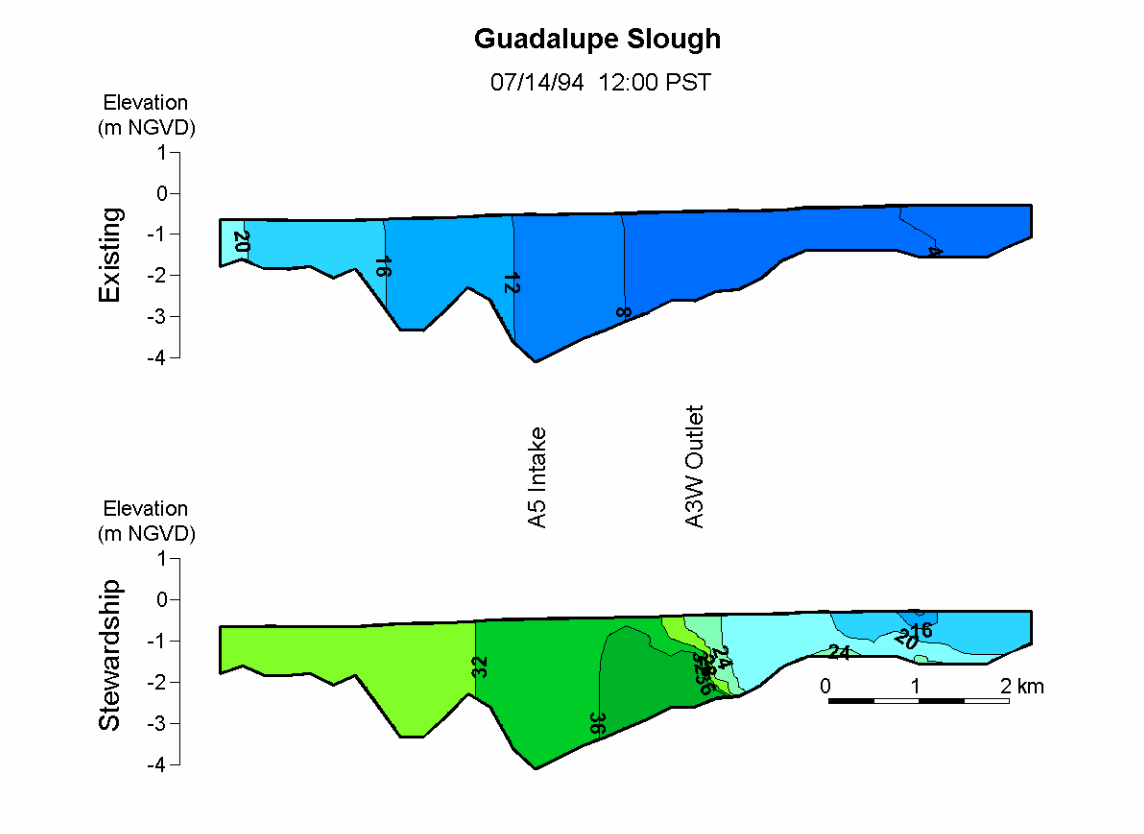
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 144. Predicted Salinity in Guadalupe Slough during the Second Month of the Initial Release Period (Commencing April 1) at a Station 5 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values”.

Figure 145. Predicted Salinity in Guadalupe Slough during **Phased Initial Release Period** after **2 Weeks** of Discharge (assumes Initial Release Commences **July 1** at **Proposed Maximum Salinity Values**)

Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.



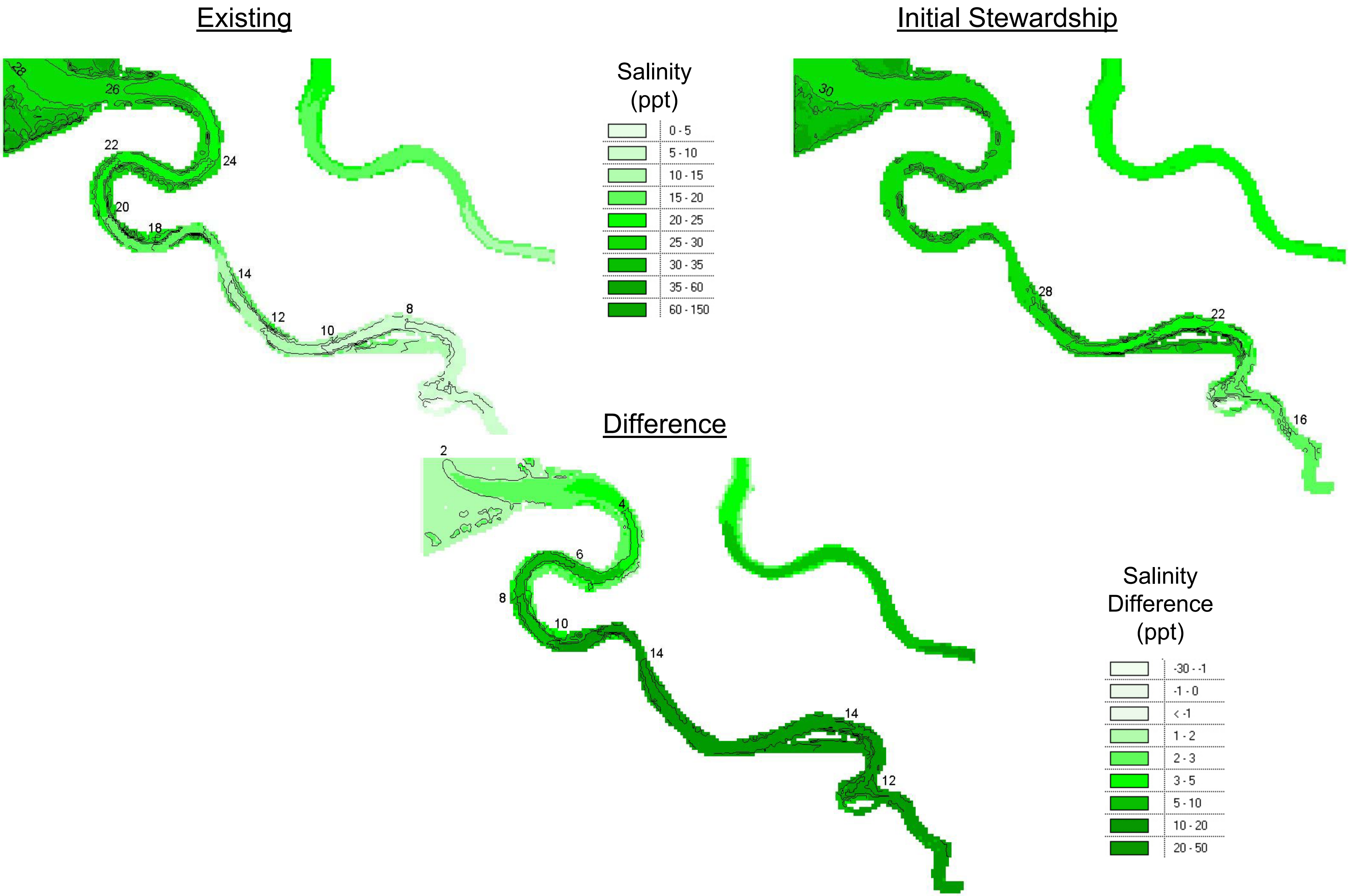


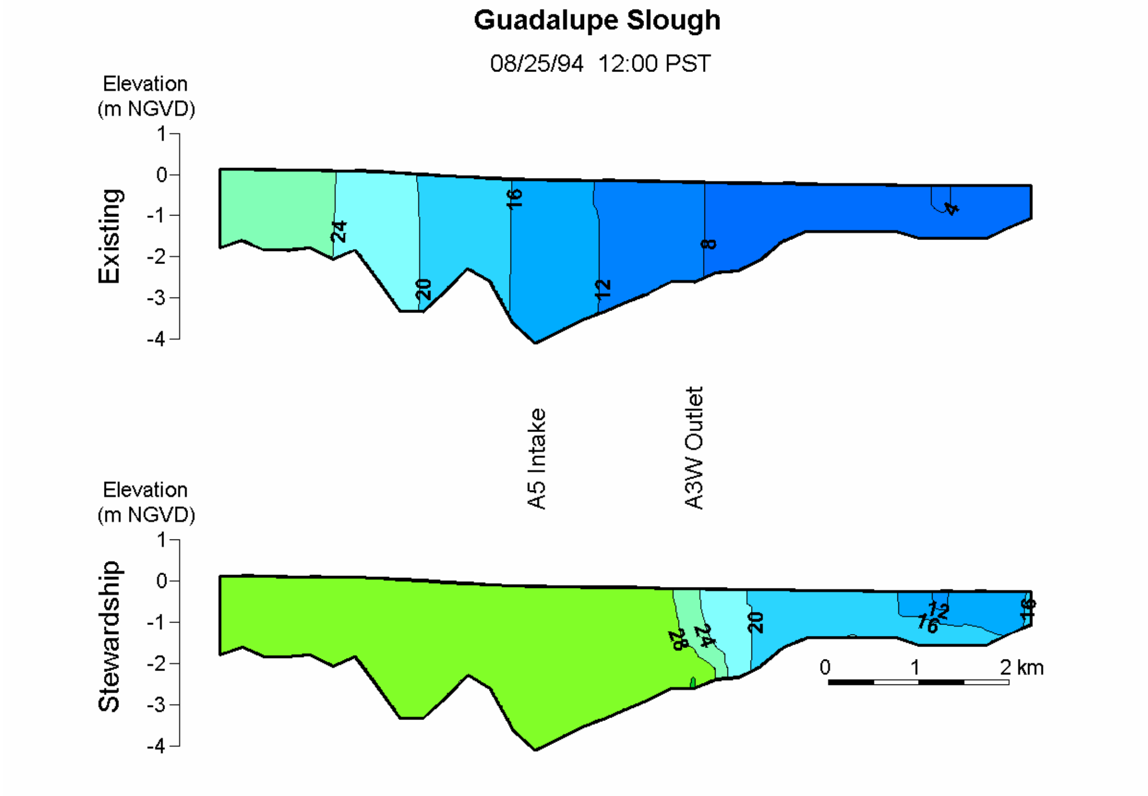
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 146. Predicted Salinity in Guadalupe Slough at the end of the Second Week of the Phased Initial Release Period (Commencing July 1). Comparison of Longitudinal Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".

Figure 147. Predicted Salinity in Guadalupe Slough during **Phased Initial Release Period** after **8 Weeks** of Discharge (assumes Initial Release Commences **July 1** at **Proposed Maximum Salinity Values**)

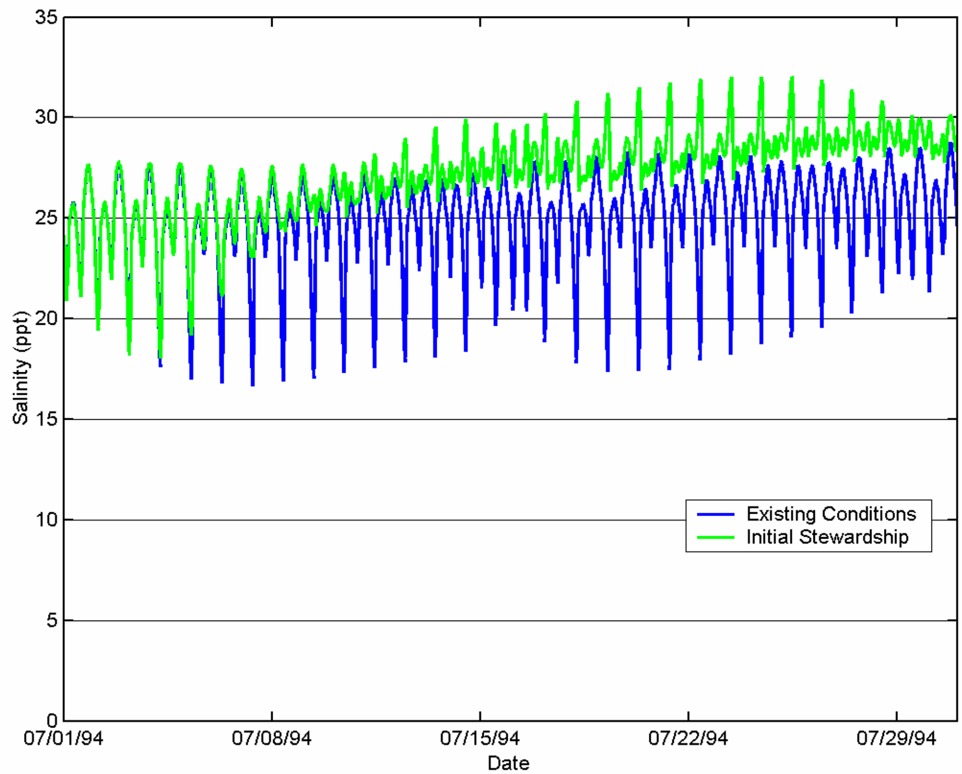
Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.





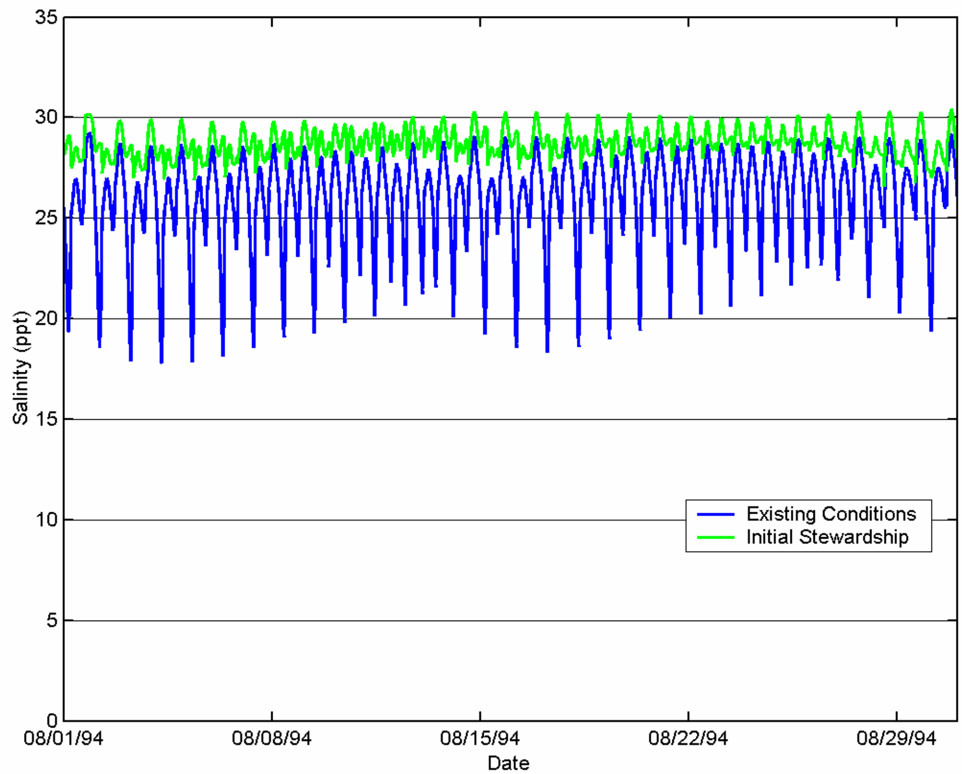
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 148. Predicted Salinity in Guadalupe Slough at the end of the Eighth Week of the Phased Initial Release Period (Commencing July 1). Comparison of Longitudinal Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".



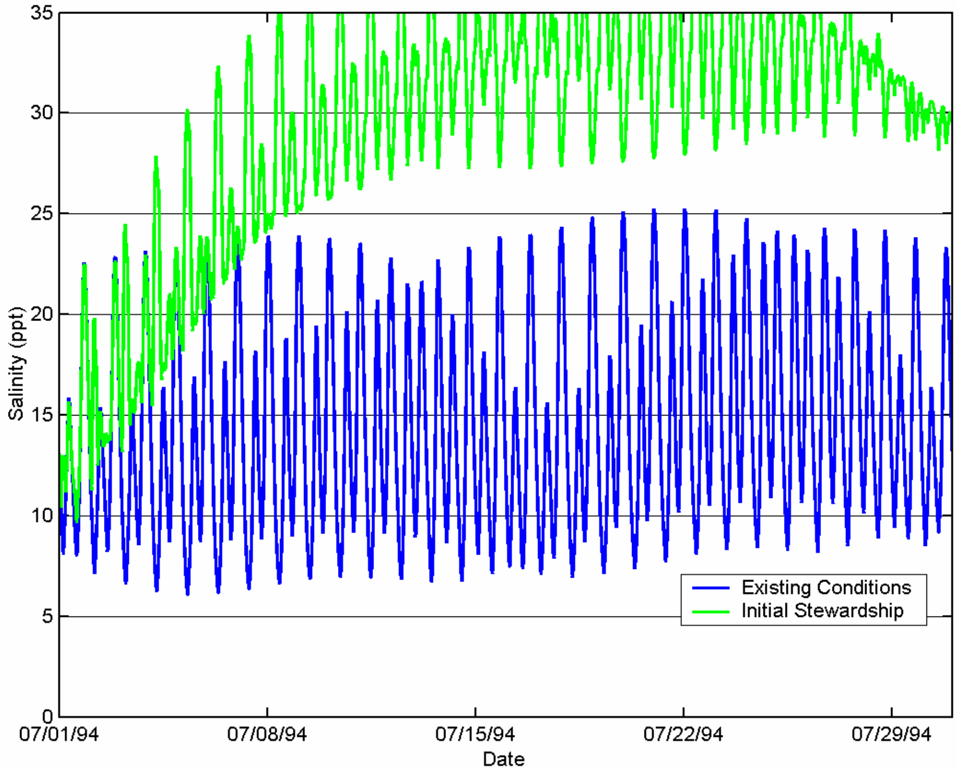
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 149. Predicted Salinity in Guadalupe Slough during the First Month of the Phased Initial Release Period (Commencing July 1) at a Station 1 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for "Existing Conditions" and "Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values".



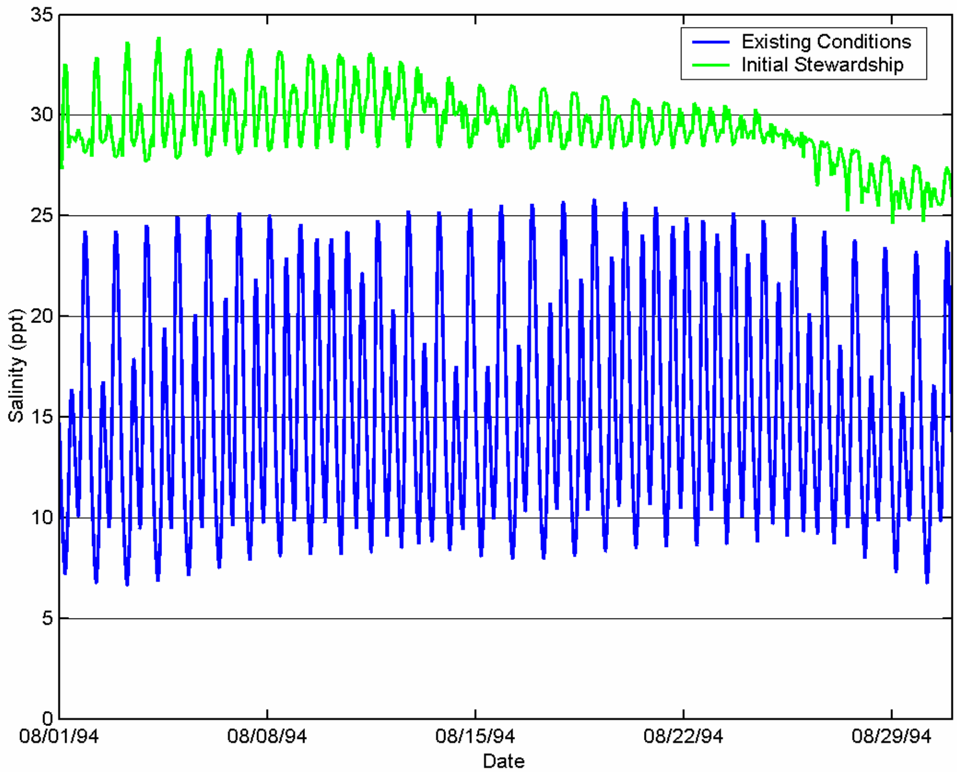
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 150. Predicted Salinity in Guadalupe Slough during the Second Month of the Phased Initial Release Period (Commencing July 1) at a Station 1 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values”.



Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 151. Predicted Salinity in Guadalupe Slough during the First Month of the Phased Initial Release Period (Commencing July 1) at a Station 5 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values”.

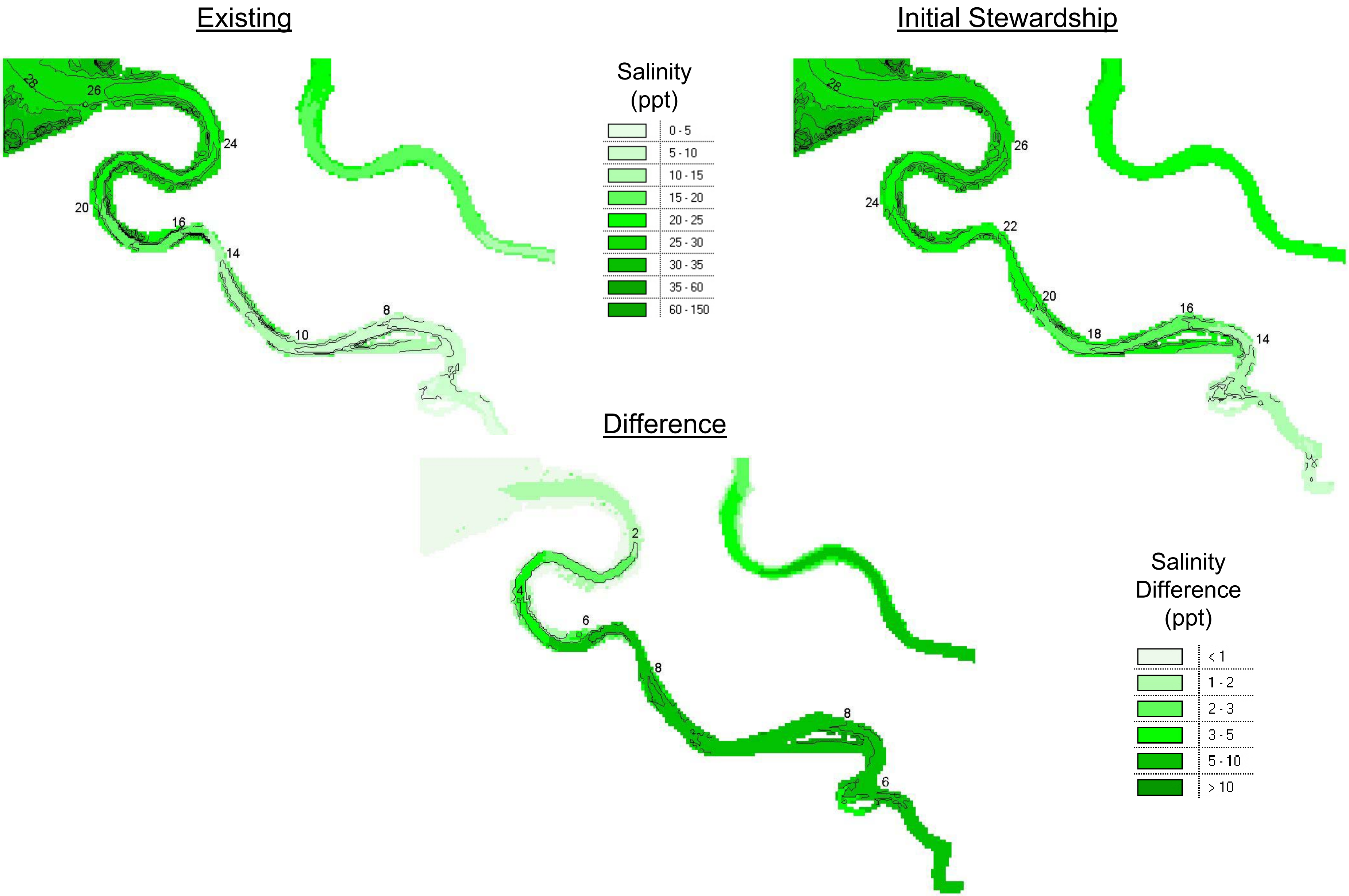


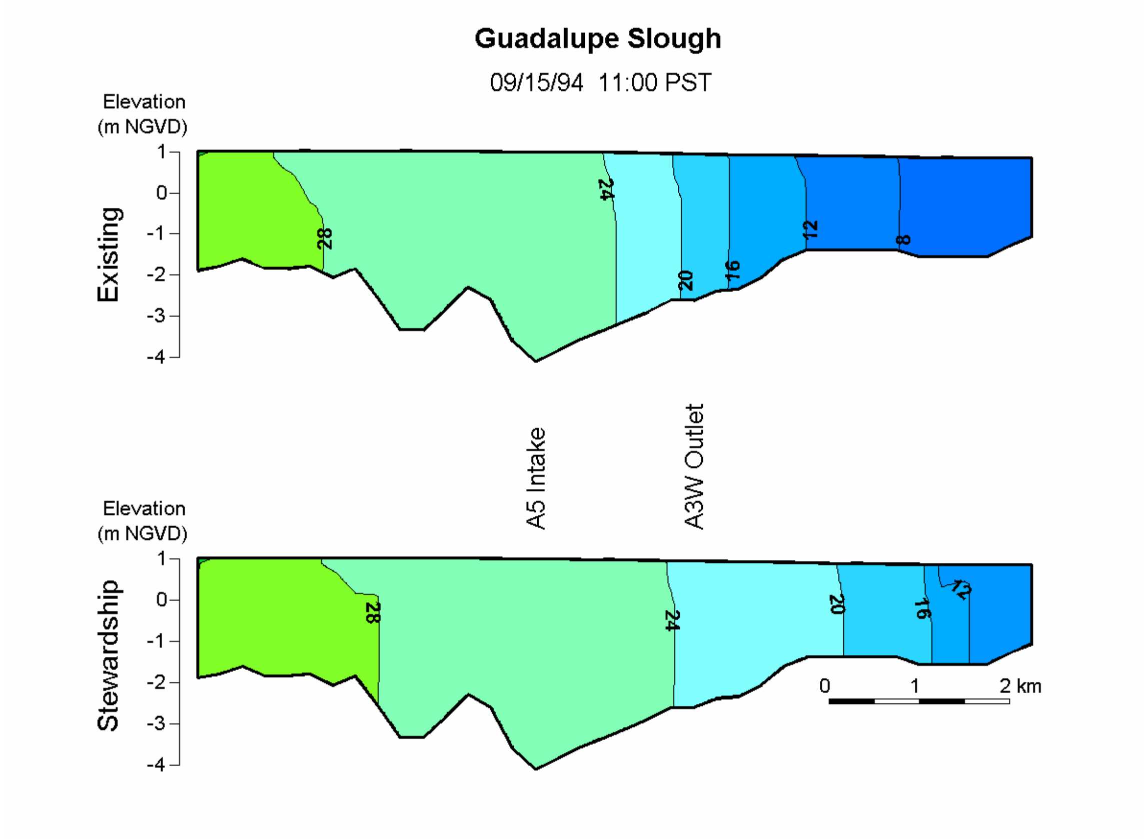
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 152. Predicted Salinity in Guadalupe Slough during the Second Month of the Phased Initial Release Period (Commencing July 1) at a Station 5 km Upstream from the Mouth. Comparison of Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at Proposed Maximum Salinity Values”.

Figure 153. Predicted Salinity in Guadalupe Slough during **Continuous Circulation Period** in **Late Summer**
(based on 9/15/94 conditions and assumes Initial Release has been completed)

Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.





Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 154. Predicted Salinity in Guadalupe Slough in mid-September during the Continuous Circulation Period. Comparison of Longitudinal Salinity Profiles Predicted for “Existing Conditions” and “Initial Stewardship Conditions with Ponds at Continuous Circulation Salinity Values”.

Figure 155. Predicted Salinity in Guadalupe Slough during **Continuous Circulation Period** in **Winter Storm Event**
(based on 2/20/95 conditions and assumes Initial Release has been completed)

Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.

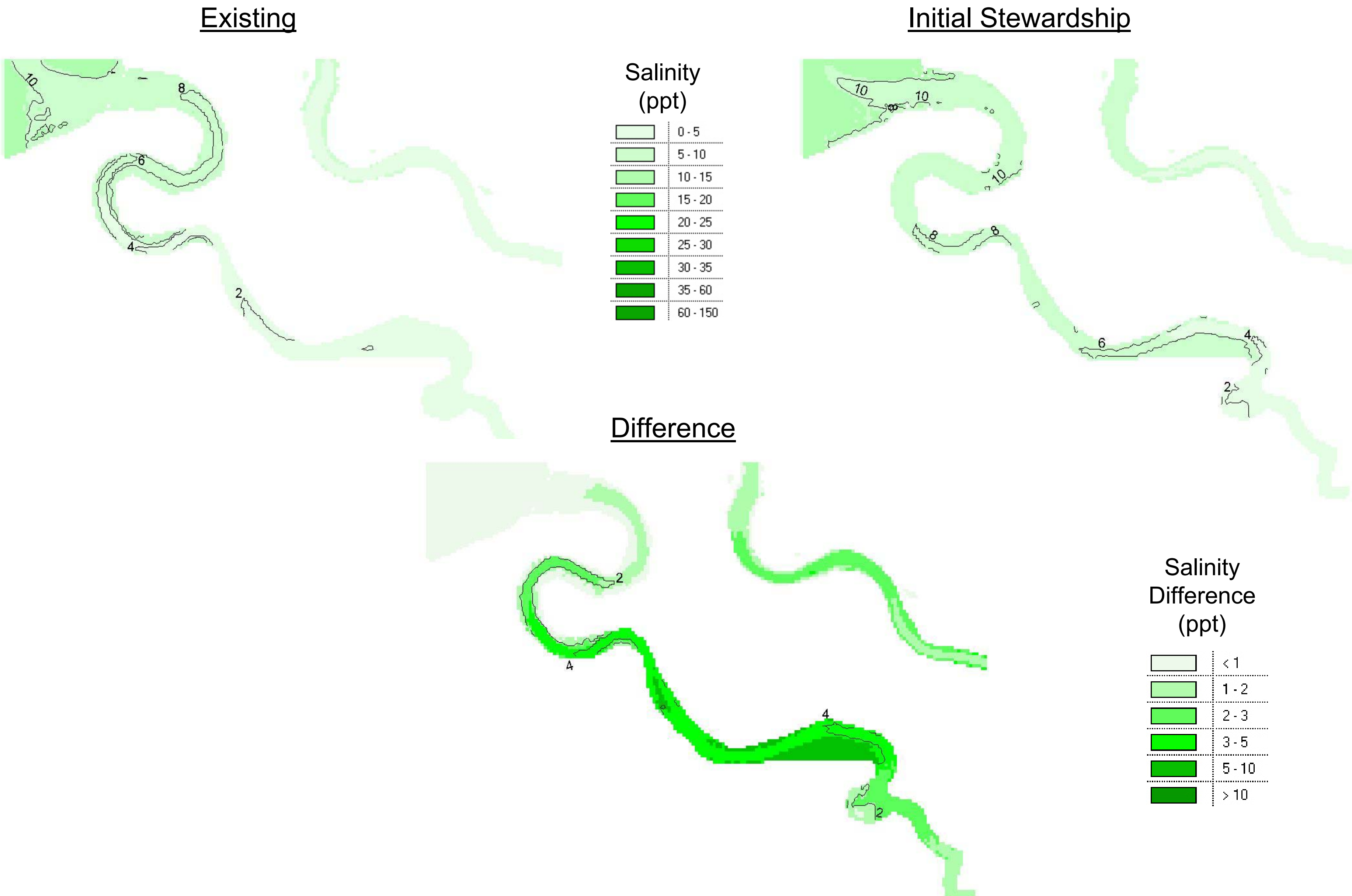
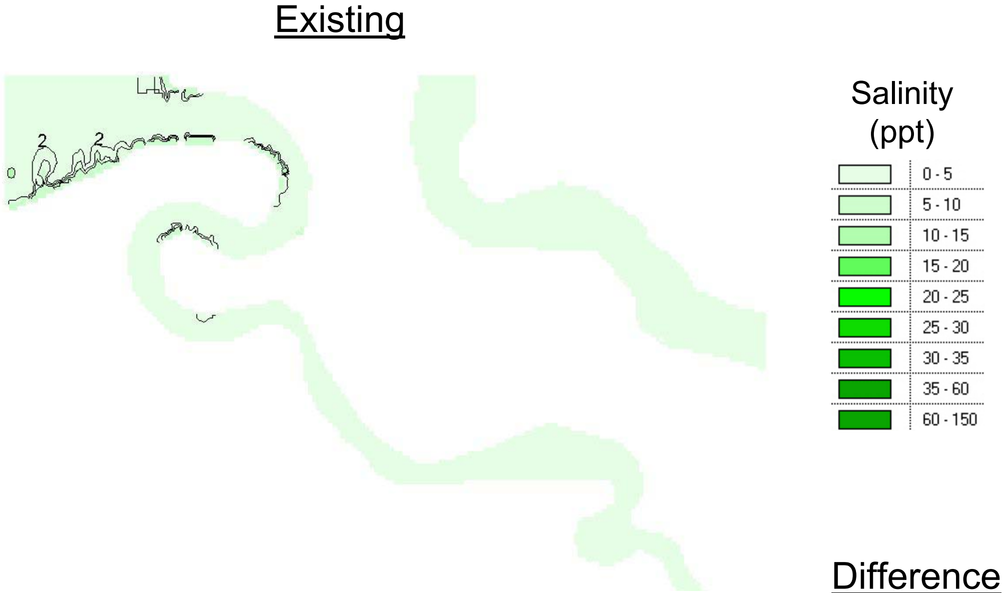
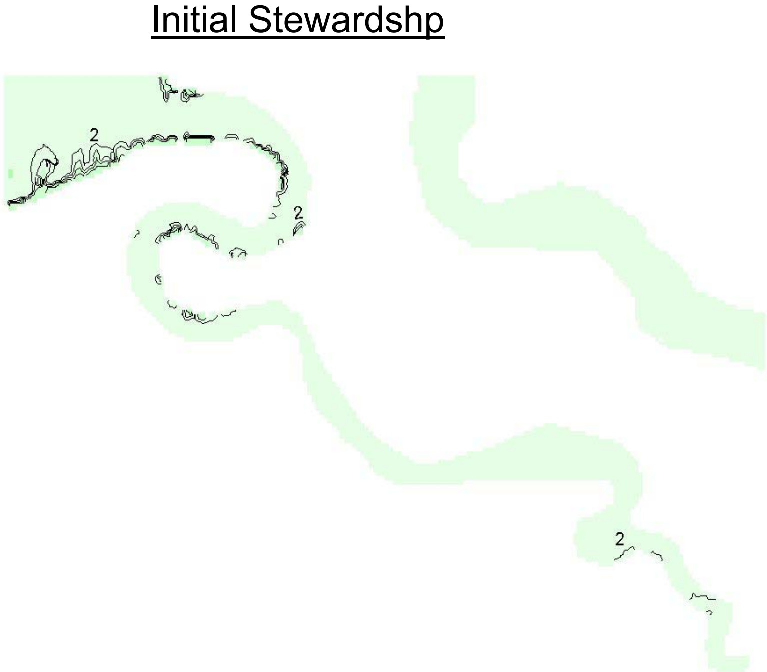


Figure 156. Predicted Salinity in Guadalupe Slough during **Continuous Circulation Period** in **Winter Dry Period**
(based on 3/10/95 conditions and assumes Initial Release has been completed)

Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.





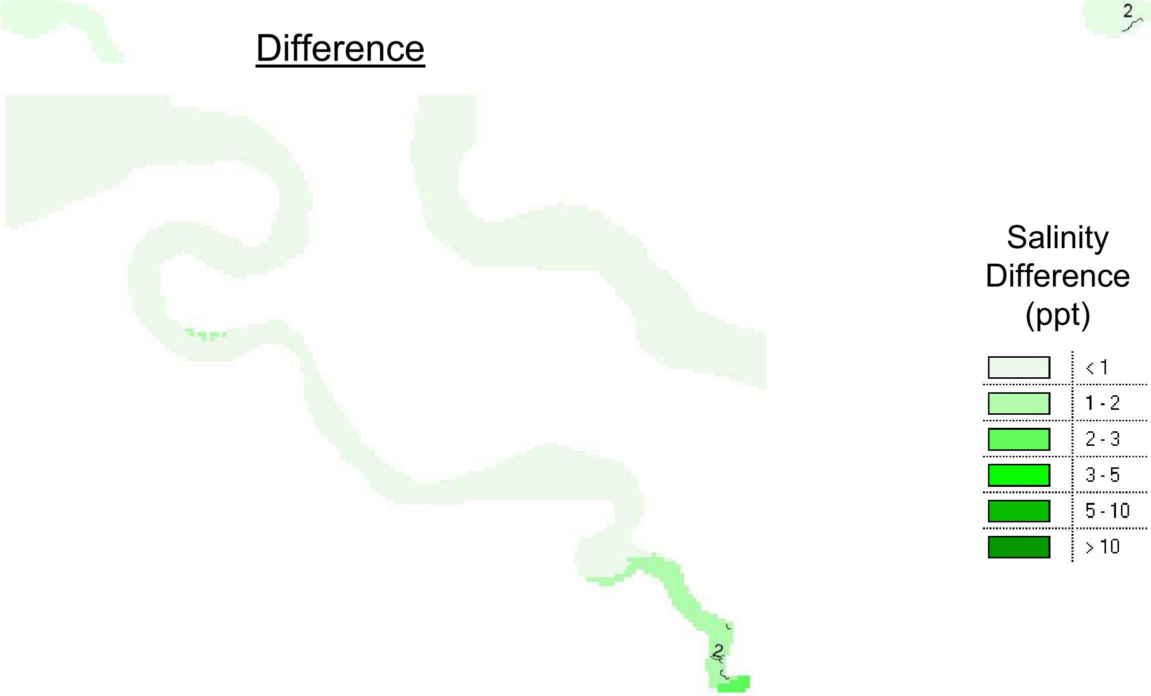
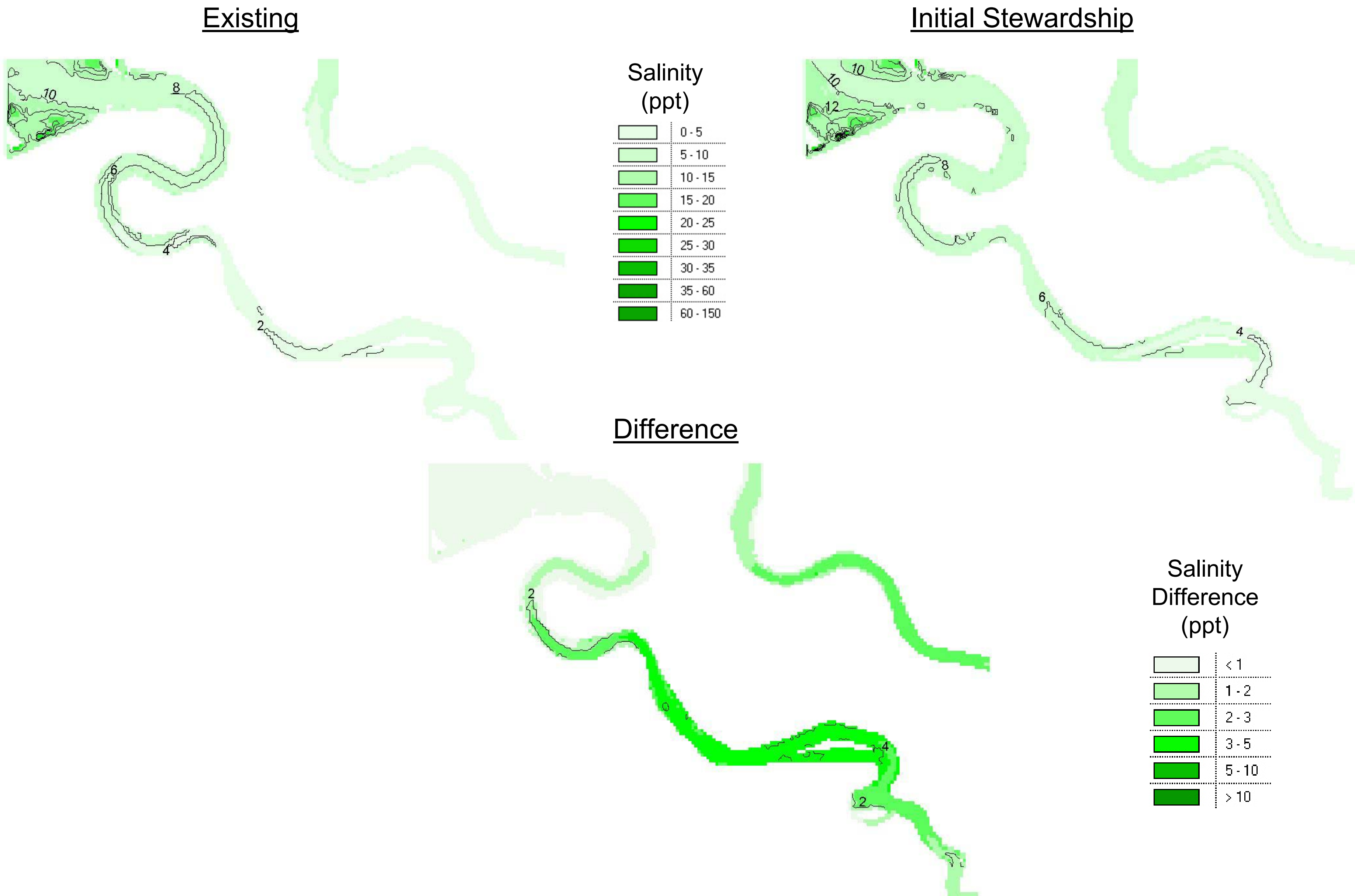


Figure 157. Predicted Salinity in Guadalupe Slough during **Continuous Circulation Period** in **Late Spring**
(based on 6/1/95 conditions and assumes Initial Release has been completed)

Note: Salinity map of AFCC indicates predicted depth-averaged and daily-averaged salinity and based on 1994-95 weather & tidal conditions.



EVALUATION OF THE POTENTIAL FOR IMPACTS ON SALMONID MIGRATION ASSOCIATED WITH CIRCULATION OF SALINE POND WATER DURING THE INITIAL STEWARDSHIP PERIOD

Prepared by
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1. OVERVIEW

Based on discussions with staff from California Department of Fish and Game, National Marine Fisheries Service, and the San Francisco Regional Water Quality Control Board, chinook salmon and steelhead trout were identified as being of particular interest in potential locations where circulated pond waters would enter receiving water bodies during the Initial Stewardship Period. The special concern for the salmonids arises from the fact that these species spawn in several of the tributaries to the South Bay and use a few of the proposed circulation areas as migration corridors to their upstream spawning grounds. There is a concern that changes in the composition of water (i.e., percentage of upstream "natal-stream" water and salinity profiles) in the circulation areas might disorient the salmonids and interrupt the upstream passage of adults and the downstream passage of juveniles through these critical areas. In addition, there is a concern that downstream migrating juveniles might be entrained into the salt ponds along with the intake water during the Initial Stewardship Period.

As described in this document, an evaluation was performed to determine to what extent "natal-stream" gradients and salinity gradients would be altered in selected sloughs and creeks as the result of saline pond water circulation and how these alterations would affect the migration of steelhead trout and chinook salmon. In addition, the life history characteristics of these salmonid species was evaluated to determine when intake of slough water should be curtailed to reduce and, if possible, eliminate entrainment of salmonid juveniles. The results of these evaluations indicate that changes in "natal-stream" profiles and salinity profiles associated with the circulation are relatively small and localized and are not expected to adversely impact the ability of adult steelhead trout or chinook salmon to migrate upstream through the sloughs to their spawning grounds. In addition, adverse impacts to downstream migrating juvenile salmon can be minimized and/or eliminated by curtailing intake of slough water from the beginning of December to the end of April. The evaluations upon which these conclusions are based are described in the following sections of this document.

2. WHERE AND WHEN SALMONIDS ARE PRESENT

Steelhead trout and chinook salmon have been reported to occur in areas designated to receive the circulation of saline waters from the South Bay salt ponds and/or serve as intake points . In order to assess the potential for impacts to these species, the distribution, abundance, and timing of these species in the vicinity of the proposed circulation locations was estimated based on a review of the scientific literature as well as interviews with staffs of federal, state, and local resource agencies. The results of this evaluation are summarized in Table 1 (which lists where these salmonids are found) and Table 2 (which describes when these species would likely be present in the circulation areas). A more thorough review of the distribution, abundance, and life history characteristics of steelhead trout and chinook salmon are provided below.

Steelhead Trout - This species (*Oncorhynchus myskiss*) is native in tributaries to South San Francisco Bay, using these streams for spawning and rearing of juveniles. Small runs of steelhead trout have been identified in Coyote Creek and Guadalupe River (which discharges into Alviso Slough), with each run numbering approximately 100 to 300 individuals annually (personal communication: J. Abel, Santa Clara Water District; G. Stern, NMFS). The steelhead do not spawn in those sections of Coyote Creek and Alviso Slough which could potentially receive saline water circulated from the South Bay salt ponds during the Initial Stewardship Period, but would use these sections as migration corridors to upstream spawning and rearing sites. According to M. Roper (CDF&G), there is an effort to develop a steelhead run in Alameda Creek. Apparently, this species has historically used Alameda Creek, but is unable to do so now due to man-made physical blockages which prevent upstream migration. Efforts are being made to physically transport upstream migrating adult steelhead around these blockages so they can reach their spawning grounds.

Due to their life history strategy, steelhead trout are only present in the potential circulation areas during limited portions of the year. Generally, adult steelhead migrate from the ocean to the South Bay tributaries from late December through early April, with the greatest activity in January through March. It would be during this time frame that adult steelhead would be migrating through the potential circulation areas. Spawning occurs in the upper reaches of the Coyote Creek and Alviso Slough/Guadalupe River watersheds, well upstream of any elevated salinity plume. After either 1 or 2 years of rearing, juvenile steelhead migrate from their upstream rearing areas to the ocean. Most of this downstream migration of juveniles occurs between February and May, with the peak between March and April. It is during this period that the juveniles would pass through the potential circulation areas.

The steelhead remain in the ocean for 2 to 4 years until they reach reproductive condition. At that point, they migrate into the estuary and return to their South Bay tributaries to spawn. Once spawning has occurred, the adults swim downstream and return to the ocean. Each winter, for several successive years, these adults repeat their upstream migration to spawn and, subsequent, downstream migration to the ocean waters.

Chinook Salmon - This species (*Oncorhynchus tshawytscha*) is not native in tributaries to South San Francisco Bay. Chinook salmon were first observed in South Bay tributaries in the early 1980s and, based on genetic analyses, are probably from Sacramento River hatchery stock (personal communication G. Stern, NMFS). Small runs of this species have been identified in Coyote Creek and Guadalupe River (which discharges into Alviso Slough), with each run numbering approximately 100 to 200 individuals annually (personal communication: J. Abel, Santa Clara Water District). The chinook salmon do not spawn in those sections of Coyote Creek and Alviso Slough which could potentially receive saline water circulated from the South Bay salt ponds during the Initial Stewardship Period, but would use these sections as migration corridors to upstream spawning and rearing sites.

Due to their life history strategy, chinook salmon are only present in the potential circulation areas during limited portions of the year. Generally, these fall-run adult chinook salmon migrate from the ocean to the South Bay tributaries from late September through November. It would be during this timeframe that adult fish would be migrating through the potential circulation areas. Spawning occurs in November through December in the upper reaches of the Coyote Creek and Alviso Slough/Guadalupe River watersheds, well upstream of any elevated salinity plume. After a few months of rearing, juvenile chinook salmon generally migrate from their upstream rearing areas to the ocean. Most of this downstream migration occurs between mid-March and early May. However, during big winter storm events, these juvenile salmon could be carried downstream as early as January or February. It is during this period that the juveniles would pass through the potential circulation areas.

The chinook salmon remain in the ocean for 2 to 4 years until they reach reproductive condition. At that point, they complete their life cycle by migrating into the estuary and returning to their South Bay tributaries to spawn. Unlike steelhead trout, the chinook salmon adults spawn only once and die after their first and only upstream migration.

3. POTENTIAL IMPACTS TO SALMONID MIGRATIONS

A concern has been raised by the resource agencies that the circulation of pond water into the proposed slough areas during the Initial Stewardship Period may adversely affect the ability of (1) adult salmonids to reach their upstream spawning areas and (2) juvenile salmonids to successfully migrate downstream from their natal streams to the ocean. Each of these concerns is discussed below.

Adult Upstream Migration - Upstream migrating adult steelhead trout and adult chinook salmon are both thought to be following a chemical signal to their spawning areas. The exact nature of this signal is not known, but is thought to be associated with some mixture of water-borne chemical constituents which are unique to the stream in which they were born and to which they are returning to spawn. It has been suggested that for upstream migration to be successful, there should be an increasing concentration of this chemical signal as one moves upstream in the sloughs and streams leading to the spawning areas. Since the exact chemical compounds that serve as signals for the upstream migration have not been identified, it is reasonable to assume that maintenance of a "natal-stream water" gradient (i.e., concentration of natal-stream water increases as one moves further upstream) may be a reasonable surrogate. If the circulation of pond water during the Initial Stewardship Period interrupts this "natal-stream water" gradient, upstream migration of chinook salmon and/or steelhead trout could be impaired.

It has also been hypothesized that a decreasing salinity gradient might be playing a role in guiding salmonids to their upstream spawning areas. Consequently, significant interruptions in these salinity gradients in the sloughs and creeks used by steelhead trout and chinook salmon as migration corridors might impair their upstream migrations.

Juvenile Downstream Migration - The downstream migration of steelhead trout and chinook salmon juveniles occurs primarily between March and May. However, since these juveniles are traveling towards the more saline waters of the South Bay and eventually the ocean, it does not seem likely that zones of elevated salinity would adversely affect their downstream migrating behavior as long as the salinity was not high enough to cause mortality or other acute impacts.

There is, however, a potential that the downstream migrating juveniles could be entrained into the salt ponds along with water taken from the sloughs as intake for the planned circulation patterns. As part of the Initial Stewardship Period operation plan, intakes will be situated on Alviso Slough (into Pond A9), Coyote Creek (into Pond A17), and Alameda Flood Control Channel (into Pond 1C). Any juvenile salmonids entrained into the salt ponds would likely be lost from the population.

4. EVALUATION OF ENTRAINMENT OF JUVENILES

As described above, there is a potential that downstream migrating juvenile salmonids (both chinook salmon and steelhead trout) would be entrained along with intake water into the salt ponds during the Initial Stewardship Period. To eliminate any possibility of such an occurrence, it was decided in consultation with NMFS to close the intakes on all salmonid creeks and sloughs from December 1 through April 30. This period encompasses the peak downstream juvenile migration period (March through April) as well as any early storm-induced juvenile washouts (late December through February). During the first year of discharge, this closure period may be shortened by one month (i.e., December 1 – March 31) for the A9 intake from Alviso Slough in order to prevent higher than desired salinities in the A14 discharge. During subsequent years, the A9 intake will observe the December 1 through April 30 closure period.

5. EVALUATION OF DISRUPTION OF NATAL-STREAM GRADIENTS

An evaluation was performed to determine whether the circulation of saline waters from the salt ponds during the Initial Stewardship Period would interfere with the “natal-stream” gradient in the sloughs and creeks used by salmonids as migration corridors to their upstream spawning areas. This evaluation was targeted to those sloughs and creeks actually used by salmonids (i.e., Alviso Slough, Coyote Creek, and Alameda Flood Control Channel) and to those times during which the peak upstream migrations actually occur (i.e., January-March for steelhead trout and September-November for chinook salmon). It should be noted that the Initial Release Period (either April-May or July-August), when the highest salinity discharges will occur, is not considered in this evaluation because the adult salmon do not migrate upstream during those months.

The evaluation consisted of three components. First, the three sloughs used by salmonids as migration corridors were each divided into 1-km segments. The boundaries of these segments are illustrated in Figures 1-3. Second, using modeling techniques, the percentage of various types of water (i.e., upstream “natal” river water, bay water, saline pond water) in each segment was predicted under existing and Initial Stewardship conditions. Third, the existing condition and Initial Stewardship condition predictions were compared to determine if discharge from the ponds during the Initial Stewardship Period would produce a break in the "natal-stream gradient" and, if so, whether adult salmon migration would be adversely impacted.

The results of these evaluations clearly indicate that circulation of saline water during the Initial Stewardship Period is not expected to disrupt the "natal-stream" gradients in the sloughs and creeks used by adult salmonids as migration corridors to their upstream spawning areas. In all cases examined, the magnitude of the gradient will not decrease due to the addition of saline pond water and adult steelhead trout and adult chinook salmon should have a strong "natal-stream" signal to follow to their spawning grounds. The results for each critical slough-time combination are presented and discussed below.

Alviso Slough - Fall: The predicted compositions of water types under existing and Initial Stewardship conditions in Alviso Creek during the period, September through November, are illustrated in Figures 4-6. As can be seen, a clear positive "natal-stream" gradient (i.e., concentration increases as one moves upstream) is predicted to exist at a similar magnitude under both existing and Initial Stewardship conditions. Consequently, during the Initial Stewardship Period, upstream migrating adult chinook salmon should have a strong "natal-stream" signal to follow to their spawning grounds.

Coyote Creek - Fall: The predicted compositions of water types under existing and Initial Stewardship conditions in Coyote Creek during the period, September through November, are illustrated in Figures 7-9. As can be seen, a clear positive "natal-stream" gradient is predicted to exist at a similar magnitude under both existing and Initial Stewardship conditions. Consequently, during the Initial Stewardship Period, upstream migrating adult chinook salmon should have a strong "natal-stream" signal to follow to their spawning grounds.

Alviso Slough - Winter: The predicted compositions of water types under existing and Initial Stewardship conditions in Alviso Creek during the period, January through March, are illustrated in Figures 10-12. As can be seen, a clear positive "natal-stream" gradient (i.e., concentration increases as one moves upstream) is predicted to exist at a similar magnitude under both existing and Initial Stewardship conditions. Consequently, during the Initial Stewardship Period, upstream migrating adult steelhead trout should have a strong "natal-stream" signal to follow to their spawning grounds.

Coyote Creek - Winter: The predicted compositions of water types under existing and Initial Stewardship conditions in Coyote Creek during the period, January through March, are illustrated in Figures 13-15. As can be seen, a clear positive "natal-stream" gradient is predicted to exist at a similar magnitude under both existing and Initial Stewardship conditions. Consequently, during the Initial Stewardship Period, upstream migrating adult steelhead trout should have a strong "natal-stream" signal to follow to their spawning grounds.

Alameda Flood Control Channel - Winter: The predicted compositions of water types under existing and Initial Stewardship conditions in the Alameda Flood Control Channel during the period, January through March, are illustrated in Figures 16-18. As can be seen, a clear positive "natal-stream" gradient is predicted to exist at a similar magnitude under both existing and Initial Stewardship conditions. Consequently, during the Initial Stewardship Period, upstream migrating adult steelhead trout should have a strong "natal-stream" signal to follow to their spawning grounds.

6. EVALUATION OF DISRUPTION OF SALINITY GRADIENTS

The salinity in a tidal slough generally increases in the downstream direction. Therefore, the salinity at any given point in a tidal slough is usually lower than the salinity at any point further downstream (toward the bay). Discharges from salt ponds during the Initial Stewardship Period could lead to localized regions, near the salt pond system outlets, where there are maxima in salinity. When passing through such a local maxima, an upstream migrating adult salmonid would experience a local "salinity gradient reversal" (i.e., lower salinity to higher salinity to lower salinity). The effect that such a local "salinity gradient reversal" would have on upstream migrating adult salmonids is not known, but there is, at least theoretically, a possibility that it could confuse a fish and impede its upstream migration.

It should be noted that salinity gradient reversals occur naturally in San Francisco Bay and do not appear to hinder the upstream migration of adult salmonids. Salinity data collected for the South Bay Discharge Authority between December 1981 and November 1986 (Kinnetic Laboratories 1987) suggests that salinity reversals occur regularly and naturally in both Alviso Slough and Coyote Creek. In addition, the salinity observation data collected by the USGS for the South San Francisco Bay (Baylosis et al. 1997) demonstrate that there are reversals in the salinity gradient in the South Bay during periods of salmonid migrations. Since salmonids are known to navigate through the South Bay, Coyote Creek, and Alviso Slough during these periods, it is reasonable to assume that these natural reversals do not impede the migratory pathways of the salmonids.

Despite the uncertainty as to the importance of salinity gradients in salmon migratory behavior, an evaluation was performed to determine whether the circulation of saline waters from the salt ponds during the Initial Stewardship Period might interrupt the salinity gradient in the sloughs and creeks used by salmonids as migration corridors to their upstream spawning areas. This evaluation was targeted to those sloughs and creeks actually used by salmonids (i.e., Alviso Slough, Coyote Creek, and Alameda Flood Control Channel) and to those times during which the peak upstream migrations actually occur (i.e., January-March for steelhead trout and September-November for chinook salmon). As with the "natal-stream" gradient analysis, the Initial Release Period (either April-May or July-August), when the highest salinity discharges will occur, is not considered in this evaluation because the adult salmon do not migrate upstream during those months.

The evaluation consisted of three components. First, for each slough and relevant time period, mathematical modeling techniques were used to predict salinity gradients under existing conditions (i.e., no pond circulation). Second, using the same models, salinity gradients were predicted under Initial Stewardship conditions. Third, these existing condition and Initial Stewardship condition gradients were compared to determine if discharge from the ponds during the Initial Stewardship Period would produce significant salinity gradient reversals. It should be noted that the identification of salinity gradient reversals is dependent upon the threshold that is used – i.e., how much more saline does the upstream water have to be in order for a gradient reversal to be considered reportable). In this evaluation, two threshold values were used, 3 ppt and 1 ppt. The 3 ppt threshold is considered representative of what might be reasonably detected by salmonids and might potentially influence their behavior. The 1 ppt threshold is considered a very conservative prediction of a salinity gradient reversal and is unlikely to have an influence on salmonid migratory behavior. It should also be noted that salinity gradient reversals presented in this evaluation are calculated based on depth-averaged salinities which include reversals that only affect a portion of the water column. Salinity reversals are often due to a low salinity region near the slough bed, with no salinity reversal occurring closer to the water surface. In such cases, a zone of passage for upstream migrating adult salmonids exists in the upper portion of the water column in which the salinity gradient is intact.

The results of these evaluations clearly indicate that circulation of saline water during the Initial Stewardship Period will not significantly disrupt salinity gradients in the sloughs and creeks used by adult salmonids as migration corridors to their upstream spawning areas. During the winter months when steelhead trout are migrating upstream, model predictions based on the 3 ppt threshold indicate that for the two streams currently used (i.e., Alviso Slough and Coyote Creek) and the one stream that could potentially be used (i.e., Alameda Flood Control Channel), salinity gradients would be intact for more than 99% of the time during the Initial Stewardship Period. During the fall months when chinook salmon are migrating upstream, model predictions indicate that for Coyote Creek, salinity gradients would be intact for 100% of the time during the Initial Stewardship Period. For Alviso Slough, even though the modeling predicts a greater frequency and duration of salinity gradient reversals during this fall period, intact salinity gradients on a monthly basis are still predicted to exist for between 49 and 98% of the time. It should be noted that all predicted salinity gradient reversals were geographically limited to a relatively small area in each slough around the point of discharge from the salt pond. The model predictions indicate that during the Initial Stewardship Period salinity gradients are sufficiently intact to provide a consistent signal for upstream migration, if the steelhead trout and chinook salmon actually follow such a signal.

The results for each critical slough-time combination are presented and discussed below.

> **<u>Alameda Flood Control Channel, January-March</u>:** If obstructions were removed from the Alameda Flood Control Channel, adult steelhead trout could potentially use this channel as an upstream migration corridor to Alameda Creek and its tributaries during the winter months. According to model predictions, as illustrated in Appendix A, during the January through March period, salinity gradient reversals in the Alameda Flood Control Channel would be slightly more frequent under Initial Stewardship conditions than under existing conditions. However, as illustrated in Figure 19, for each of the three months in question, the predicted salinity gradient reversals during the Initial Stewardship Period would be infrequent and of short duration.
>
> Using a 3 ppt threshold (i.e., a salinity gradient reversal is counted only if there is a discontinuity in the gradient anywhere along the channel of 3 ppt or greater), there are no predicted salinity gradient reversals of any duration on any day over the entire three month winter period during which steelhead trout would migrate upstream. Reducing the

threshold to 1 ppt results in a slight increase in predicted reversals, with the average daily reversal having a duration of 37 min. All of these predicted reversals would have a magnitude of less than 3 ppt.

Therefore, during the January through March period, it is predicted that under Initial Stewardship conditions, steelhead trout in the Alameda Flood Control Channel would, on an average day, have a distinct, uninterrupted salinity gradient to follow through the area influenced by circulation for 100% of the time (based on a 3 ppt threshold). Local disruptions of the gradient at a magnitude of less than 3 ppt may last, on an average day during this three month period, for approximately 37 min.

Alviso Slough, September-November: Chinook salmon use Alviso Slough as an upstream migration corridor to Guadalupe River and its tributaries during the fall months. According to model predictions, as illustrated in Appendix B, during the September through November period, salinity gradient reversals in Alviso Slough would be more frequent under Initial Stewardship conditions than under existing conditions. As illustrated in Figure 20, for each of the three months in question, the predicted duration and frequency of any salinity gradient reversals would vary depending upon the threshold that is used to detect such a reversal:

> Using a 3 ppt threshold, the predicted frequency and duration of reversals during the three month fall upstream migration period are fairly low, with an average day experiencing approximately 5 hrs of reversals. In September, reversals are predicted to occur every day, with a mean duration of 12.3 hrs; which means that on an average day, the continuous salinity gradient is present for almost 12 hrs. In October, it is predicted that 9 days will experience no reversals, 11 days will have reversals of 2 hrs or less, 9 days will have reversals of between 3 and 6 hrs, 1 day will have a 9-hr reversal, and 1 day will have a 13-hr reversal. On an average day in October, the continuous salinity gradient is predicted for more than 21 hrs. In November, 19 days are predicted to have no reversals, 8 days will have a 1-hr reversal, and 3 days will have reversals lasting between 3 and 4 days. On an average day in November, the continuous salinity gradient is predicted for more than 23 hrs.
>
> Reducing the threshold to 1 ppt results in an increase in predicted reversals, with the average daily reversal having a duration of approximately 13 hrs. Eight of these 13 hrs of predicted reversals would have a magnitude of less than 3 ppt.

Therefore, during the September through November period, it is predicted that under Initial Stewardship conditions, chinook salmon will, on an average day, have a distinct, uninterrupted salinity gradient to follow through the area influenced by circulation for 78.5% of the time or approximately 19 hrs (based on a 3 ppt threshold). Local disruptions of the gradient at a magnitude of less than 3 ppt may last, on an average day during this three month period, for approximately 8 hrs.

<u>Alviso Slough, January-March</u>: Steelhead trout use this channel as an upstream migration corridor to Guadalupe River and its tributaries during the winter months. According to model predictions, as illustrated in Appendix C, during the January through March period, salinity gradient reversals in Alviso Slough would occur slightly more frequently under Initial Stewardship conditions than under existing conditions. However, as illustrated in Figure 21, for each of the three months in question, the predicted reversals in the salinity gradient would be quite infrequent and of short duration.

Using a 3 ppt threshold, the predicted frequency and duration of reversals during the three month winter upstream migration period are extremely low, with an average day experiencing just eight minutes of reversals. There are no predicted salinity gradient reversals of any duration on any day in January or March. In February, 24 days are predicted to experience no reversals and 4 days have predicted reversals of between 1 and 2 hrs. On an average day in February, the continuous salinity gradient is predicted for more than 23.9 hrs. Reducing the threshold to 1 ppt results in an increase in predicted reversals, with the average daily reversal having a duration of 3 hrs. Of this 3 hrs of predicted reversals, approximately 2 hrs 52 min would have a magnitude of less than 3 ppt.

Therefore, during the January to March period, it is predicted that under Initial Stewardship conditions, steelhead trout will, on an average day, have a distinct, uninterrupted salinity gradient to follow through the area influenced by circulation for 99.9% of the time (based on a 3 ppt threshold). Local disruptions of the gradient at a magnitude of less than 3 ppt may last, on an average day during this three month period, for approximately 3 hrs.

<u>Coyote Creek, September-November</u>: Chinook salmon use this channel as an upstream migration corridor during the fall months. According to model predictions, as illustrated in Appendix D, during the September through November period, salinity gradient reversals in Coyote Creek are slightly higher under Initial Stewardship conditions than under existing conditions. However, as illustrated in Figure 22, for each of the three months in question, the predicted salinity gradient reversals would be quite infrequent and of short duration.

Using a 3 ppt threshold, there are no predicted salinity gradient reversals of any duration on any day during the entire three month fall upstream migration period. Reducing the threshold to 1 ppt results in an increase in predicted reversals, with the average daily reversal having a duration of 9 hrs. All of these predicted reversals would have a magnitude of less than 3 ppt.

Therefore, during the September-November period, it is predicted that under Initial Stewardship conditions, chinook salmon will, on an average day, have a distinct, uninterrupted salinity gradient to follow through the area influenced by circulation for 100% of the time (based on a 3 ppt threshold). Local disruptions of the gradient at a magnitude of less than 3 ppt may last, on an average day during this three month period, for approximately 9 hrs.

<u>Coyote Creek, January-March</u>: Steelhead trout use this channel as an upstream migration corridor during the winter months. According to model predictions, as illustrated in Appendix E, during the January through March period, salinity gradient reversals in the Alameda Flood Control Channel are slightly more frequent under circulation conditions than under existing conditions. However, as illustrated in Figure 23, for each of the three months in question, the reversals would be quite infrequent and of short duration.

Using a 3 ppt threshold, there are no predicted salinity gradient reversals of any duration on any day during the entire three month winter upstream migration period. Reducing the threshold to 1 ppt results in a slight increase in predicted reversals, with the average daily reversal having a duration of approximately 1 hr. All of these predicted reversals would have a magnitude of less than 3 ppt.

Therefore, during the January to March period, it is predicted that during the Initial Stewardship Period, steelhead trout will, on an average day, have a distinct, uninterrupted salinity gradient to follow through the area influenced by circulation for 100% of the time (based on a 3 ppt threshold). Local disruptions of the gradient at a magnitude of less than 3 ppt may last, on an average day during this three month period, for approximately 1 hr.

7. OVERALL CONCLUSIONS

Steelhead trout and chinook salmon use three of the sloughs into which saline pond water will be circulated during the Initial Stewardship Period as migration corridors to upstream spawning areas. The use is seasonal, with adult steelhead primarily migrating upstream from January through March, adult chinook salmon primarily migrating upstream from September through November, and young-of-the-year of both species primarily migrating downstream from December through April.

During the Initial Stewardship Period, the major threat to downstream migrating juveniles would be the potential to be entrained into the salt ponds along with the intake water. According to the operation plan, this threat will be greatly reduced and/or eliminated by closing the intake gates from the beginning of December to the end of April, which is the duration of the peak downstream migration period.

During the Initial Stewardship Period, the major threat to upstream migrating adult salmonids would be the potential interference with the signals that lead them to their spawning areas. Two possible signals are "natal-stream" gradients and salinity gradients. Using 3-dimensional computer models, it was predicted that circulation of saline water from salt ponds during the Initial Stewardship Period would not affect the presence or magnitude of the "natal-stream" gradients in any of the sloughs used by chinook salmon or steelhead trout during their upstream migrations. Similarly, computer models predicted that salinity gradients would remain predominantly intact in the subject sloughs during the salmonid upstream migration periods. Since salmonids successfully navigate through naturally occurring salinity gradient reversals in San Francisco Bay and its tributaries, it is concluded that any reversals resulting from pond circulation would not be expected to act as a deterrent to upstream migration. It should be emphasized that the predicted salinity reversals are usually of small magnitude, of short duration, and affect a relatively small length of the migration corridor. This is illustrated in Figure 24 for breaks in the salinity gradient that are predicted in Alviso Slough in late November under Initial Stewardship Period conditions. During this period, the gradient interruptions have a magnitude of less than 3 ppt, last for less than 6 hrs, and are limited to locations near the A7 outfall.

8. LITERATURE CITED

Baylosis, J.I., Edmunds, J.L., Cole, B.E., & Cleorn, J.E. 1997. Studies of the San Francisco Bay, California Estuary Ecosystem: Pilot Regional Monitoring Results, 1996: U.S. Geological Survey Open File Report 97-598, 203pp.

Kinnetic Laboratories, Inc. 1987. South Bay Dischargers Authority Water Quality Monitoring Program: Final Monitoring Report, December 1981 – November 1986. Prepared for South Bay Dischargers Authority, San Jose, CA.

Table 1. The presence of salmonid species in each of the potential circulation sites

Circulation Location	Species of Interest Present	Description of Presence in Potential Areas of Circulation
Coyote Creek		
	Steelhead Trout	Uses area as a migration corridor to upstream spawning areas
	Chinook Salmon	Uses area as a migration corridor to upstream spawning areas
Alviso Slough		
	Steelhead Trout	Uses area as a migration corridor to upstream spawning areas
	Chinook Salmon	Uses area as a migration corridor to upstream spawning areas
Alameda Creek		
	Steelhead Trout	Only with human intervention, uses area as a migration corridor to upstream spawning
Guadalupe Slough		Neither salmonid species reported to use area
Alameda Flood Cont. Channel		Neither salmonid species reported to use area

Table 2. Temporal patterns in the abundance of salmonid species at South Bay circulation sites

Species of Interest	Presence During Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Steelhead Trout												
Upstream Migrating Adults												
Downstream Migrating Juveniles												
Chinook Salmon												
Upstream Migrating Adults												
Downstream Migrating Juveniles												

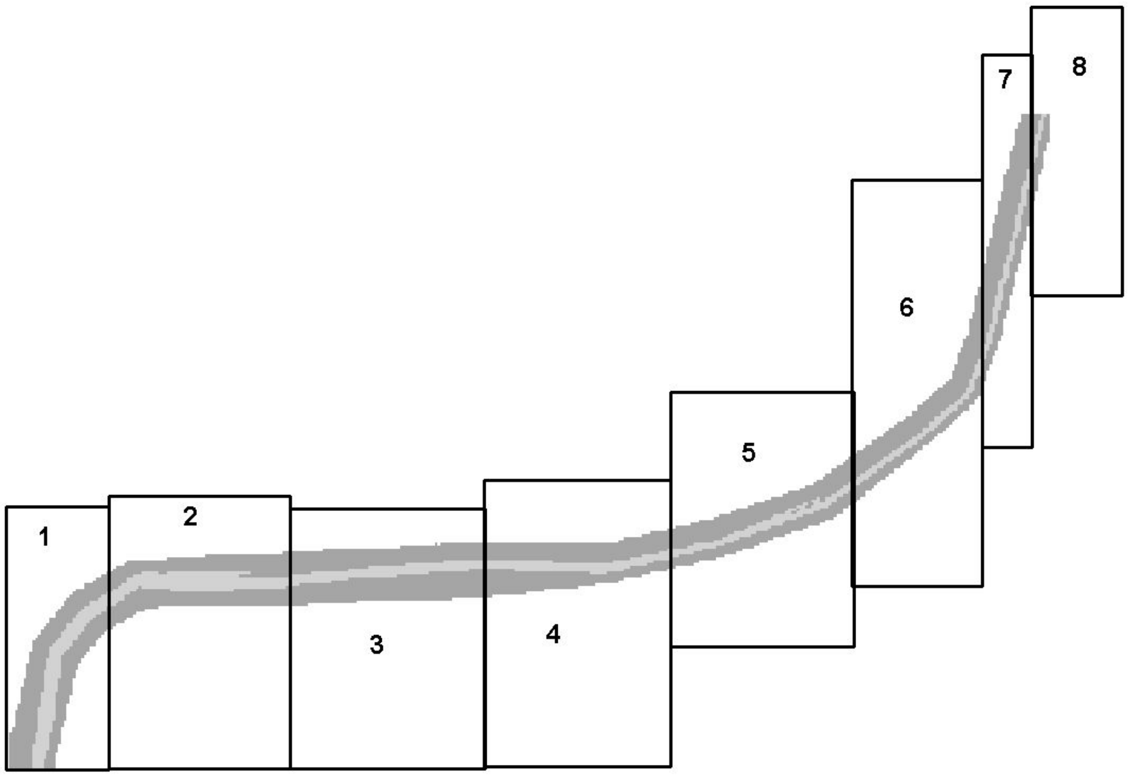


Figure 1. One Kilometer Reaches in Alameda Flood Control Channel.

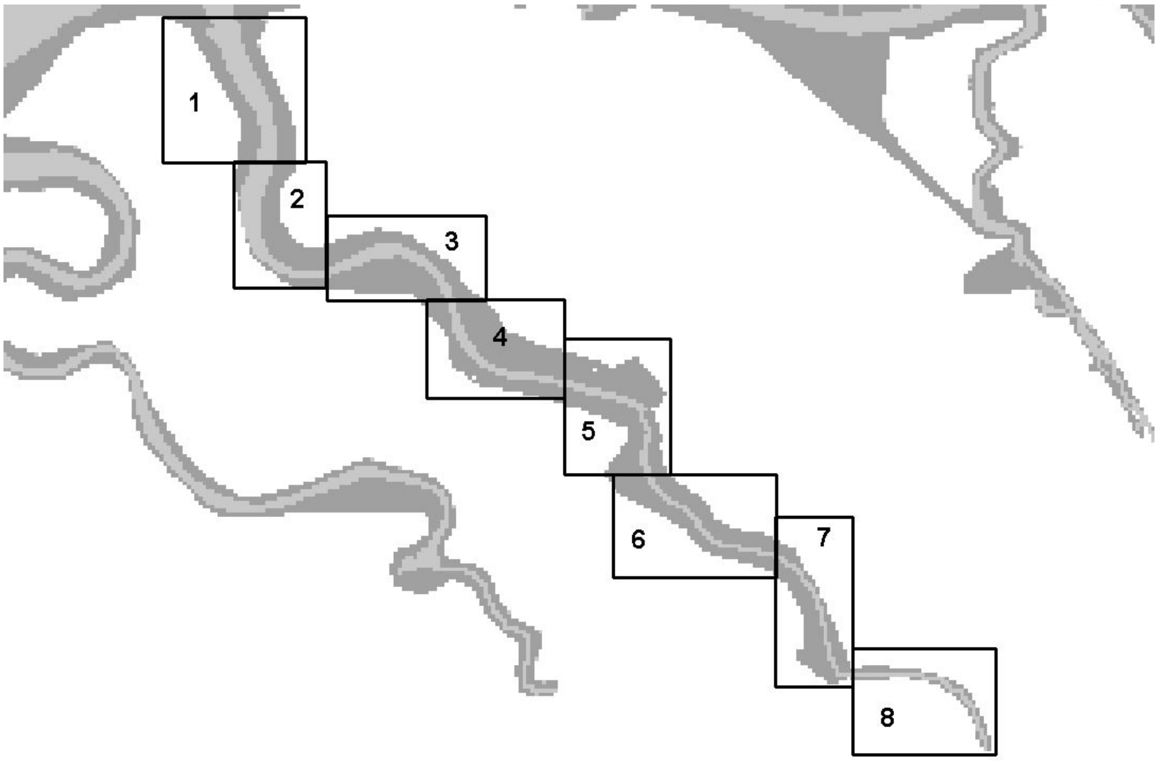


Figure 2. One Kilometer Reaches in Alviso Slough.

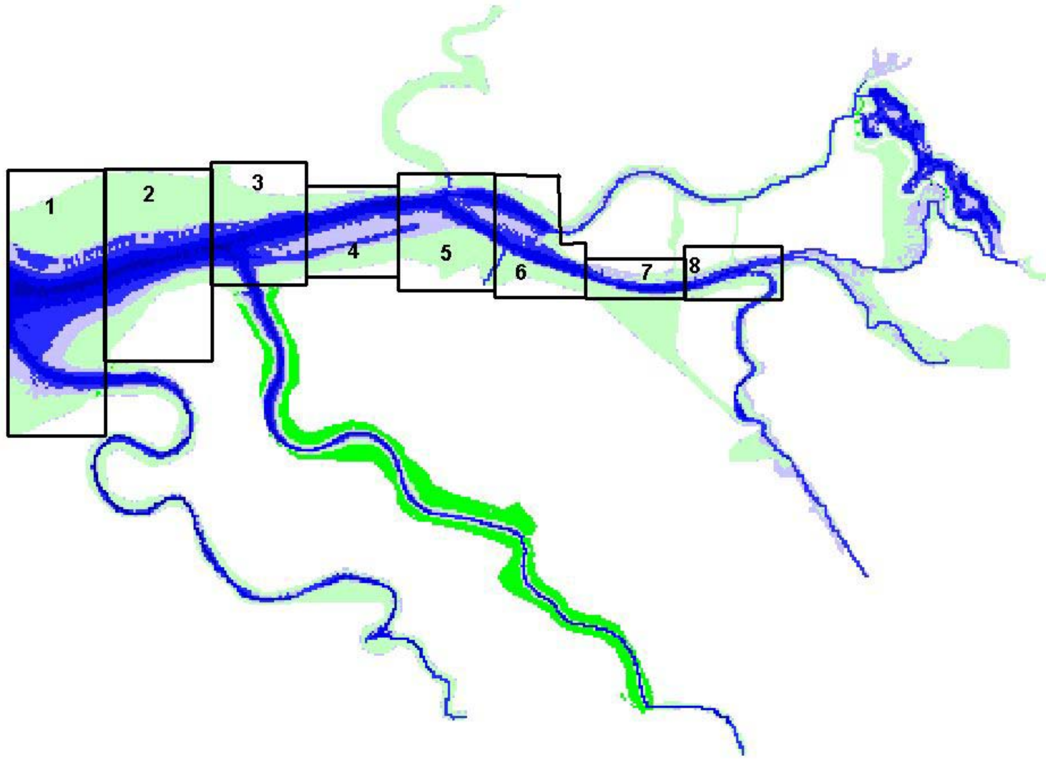
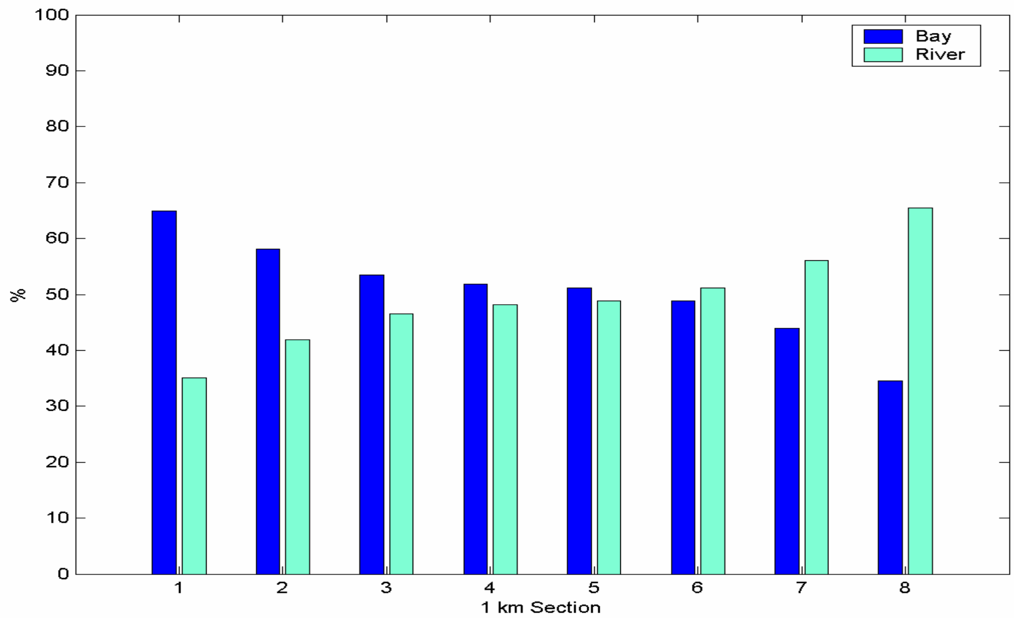


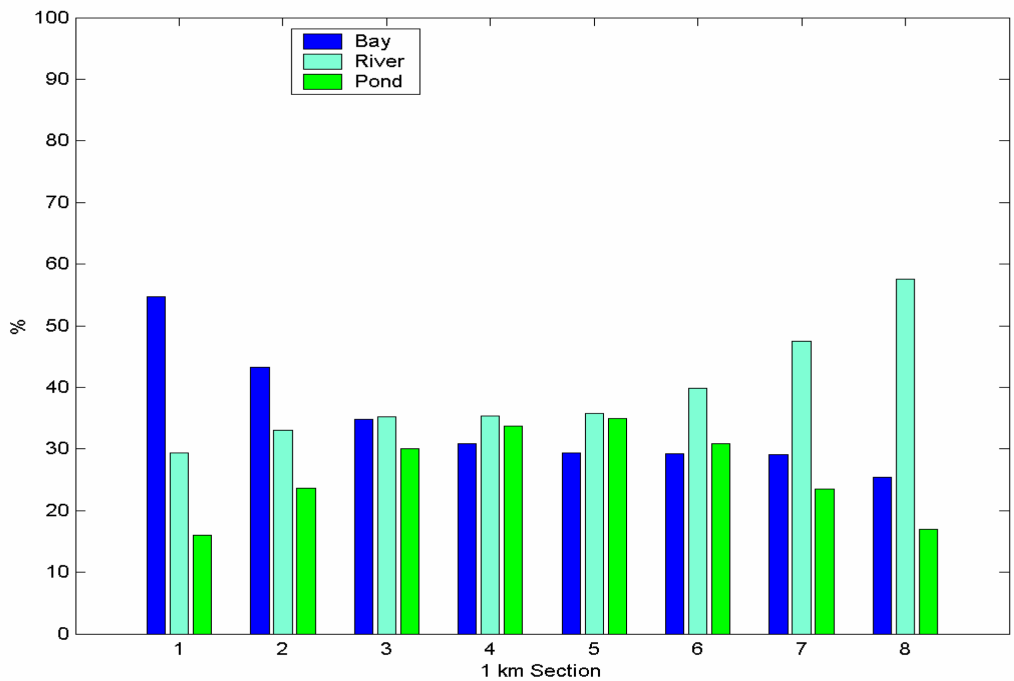
Figure 3. One Kilometer Reaches in Coyote Creek.

Figure 4. Predicted Proportions of Different Water Types along Alviso Slough in September

a. Under Existing Conditions



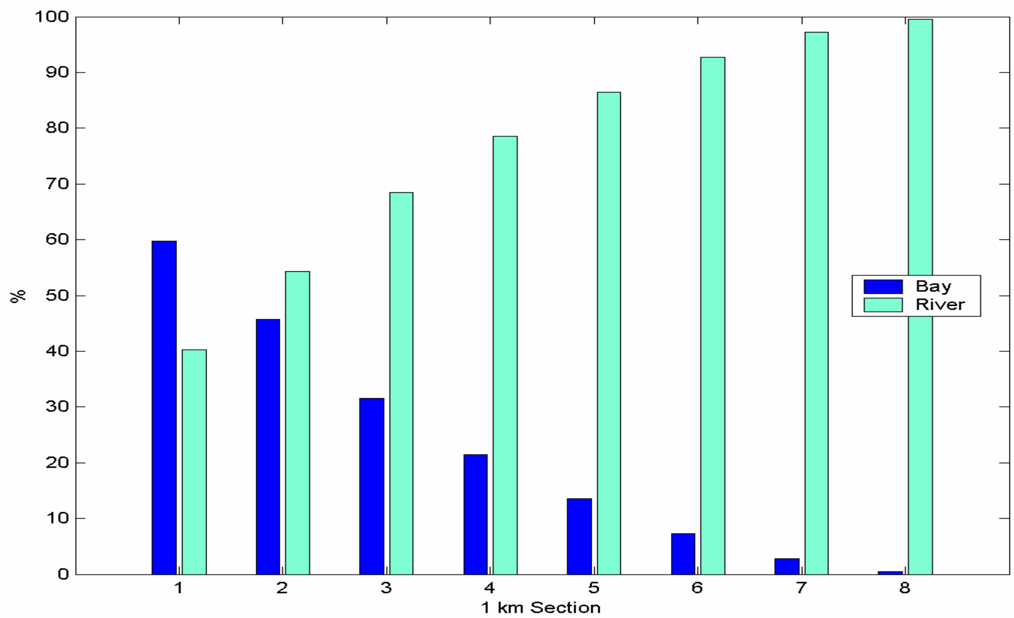
b. Under Circulation Conditions during Initial Stewardship Period



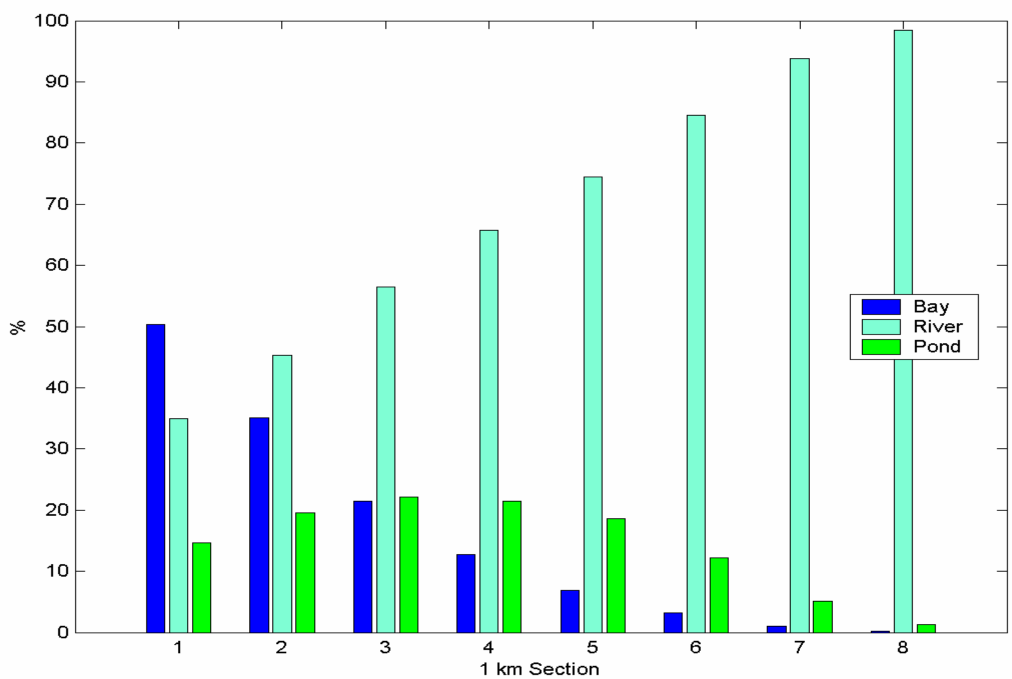
Note: Water composition computed based on volume and time averaged tracer concentration.
Predicted based on 1994-1995 weather and tidal conditions.

Figure 5. Predicted Proportions of Different Water Types along Alviso Slough in October

a. Under Existing Conditions



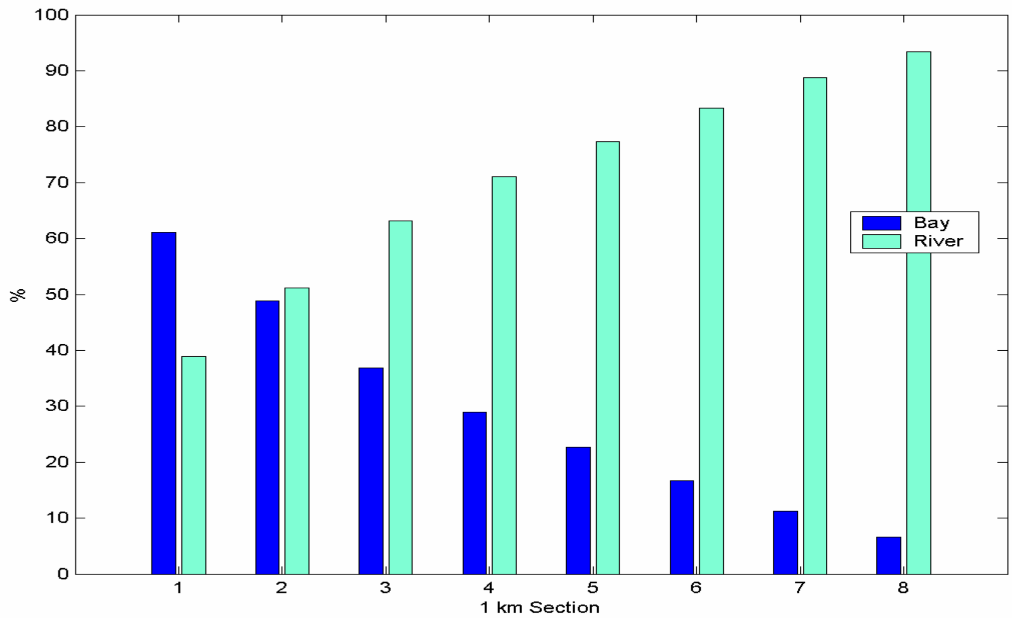
b. Under Circulation Conditions during Initial Stewardship Period



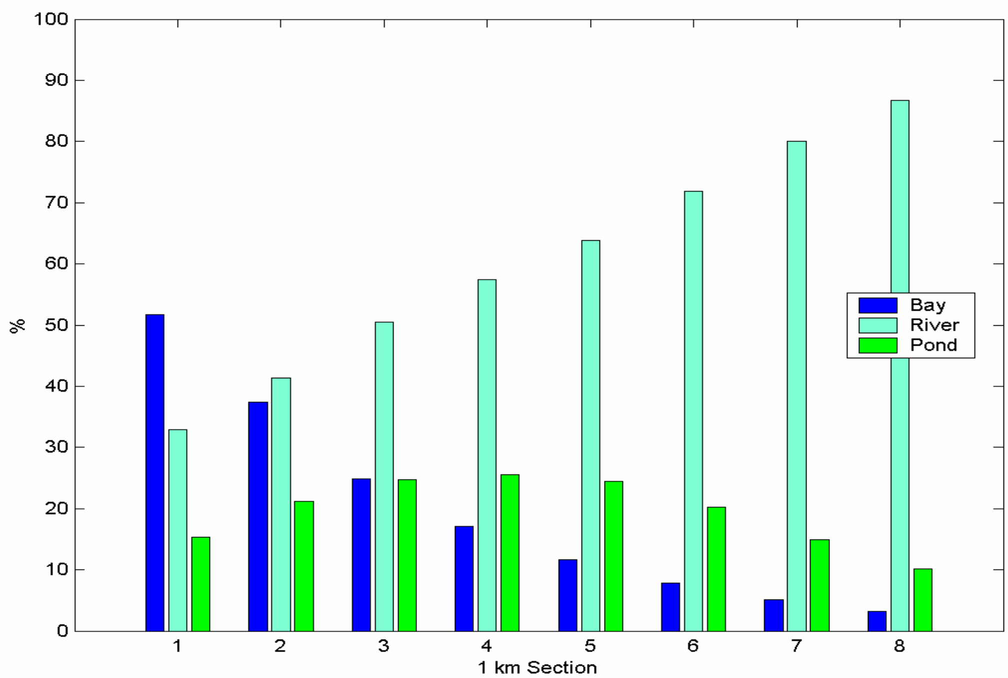
Note: Water composition computed based on volume and time averaged tracer concentration.
Predicted based on 1994-1995 weather and tidal conditions.

Figure 6. Predicted Proportions of Different Water Types along Alviso Slough in November

a. Under Existing Conditions



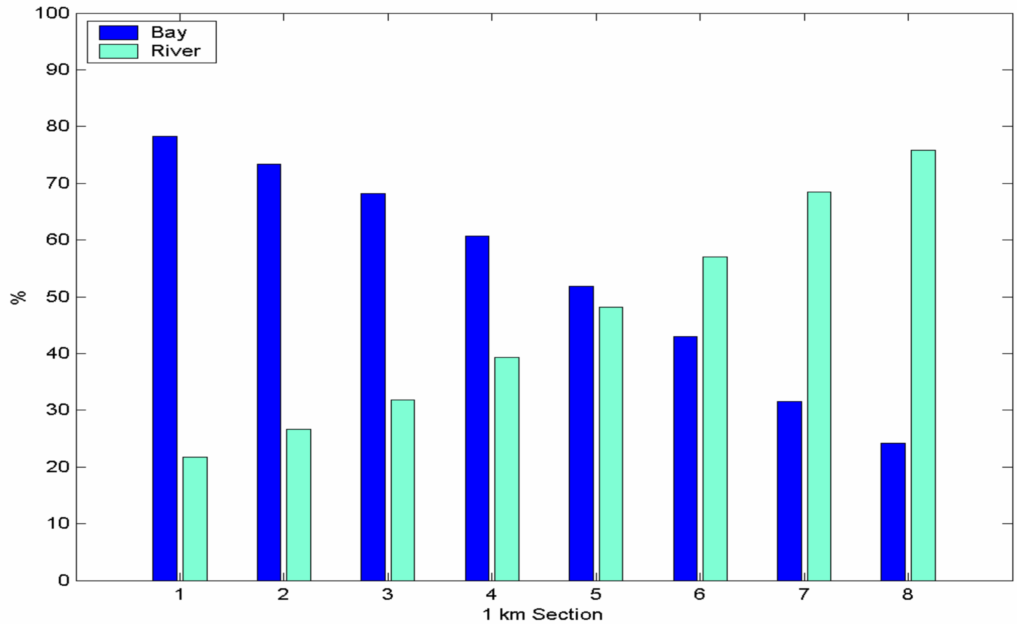
b. Under Circulation Conditions during Initial Stewardship Period



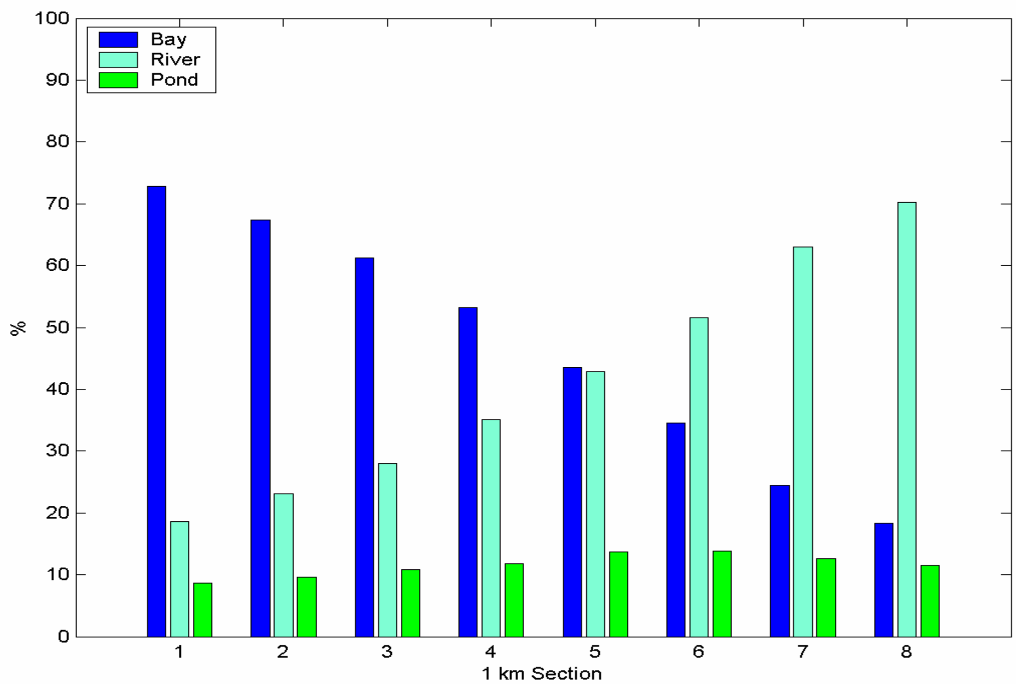
Note: Water composition computed based on volume and time averaged tracer concentration. Predicted based on 1994-1995 weather and tidal conditions.

Figure 7. Predicted Proportions of Different Water Types along Coyote Creek in September

a. Under Existing Conditions



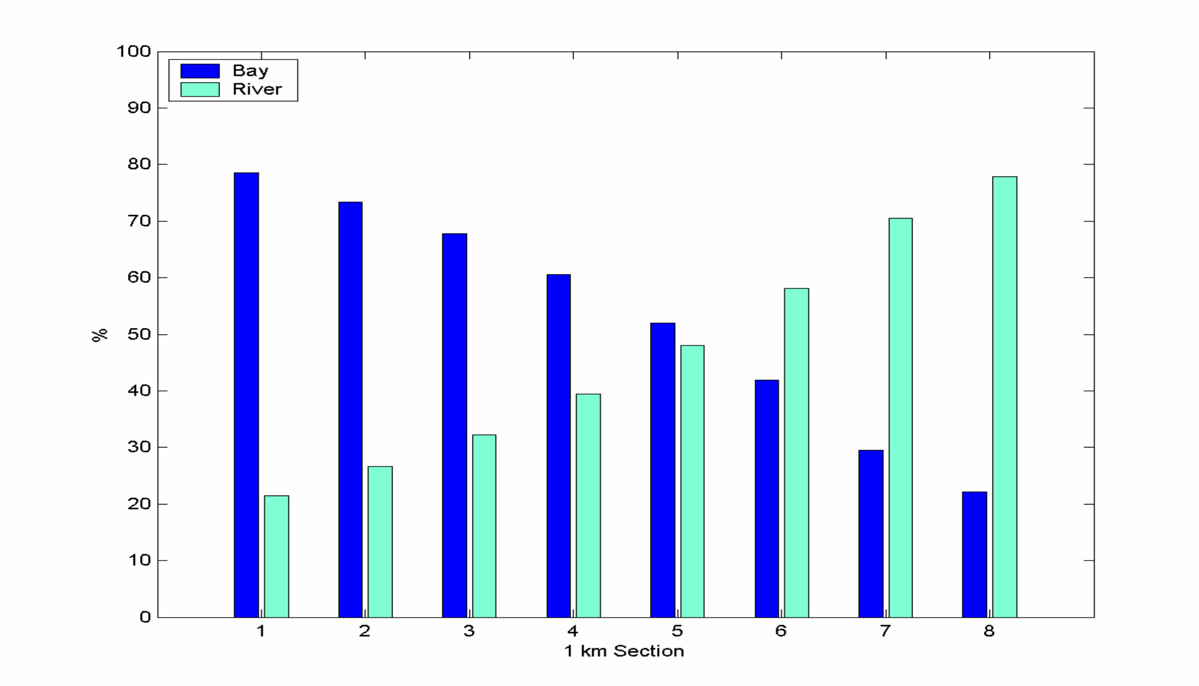
b. Under Circulation Conditions during Initial Stewardship Period



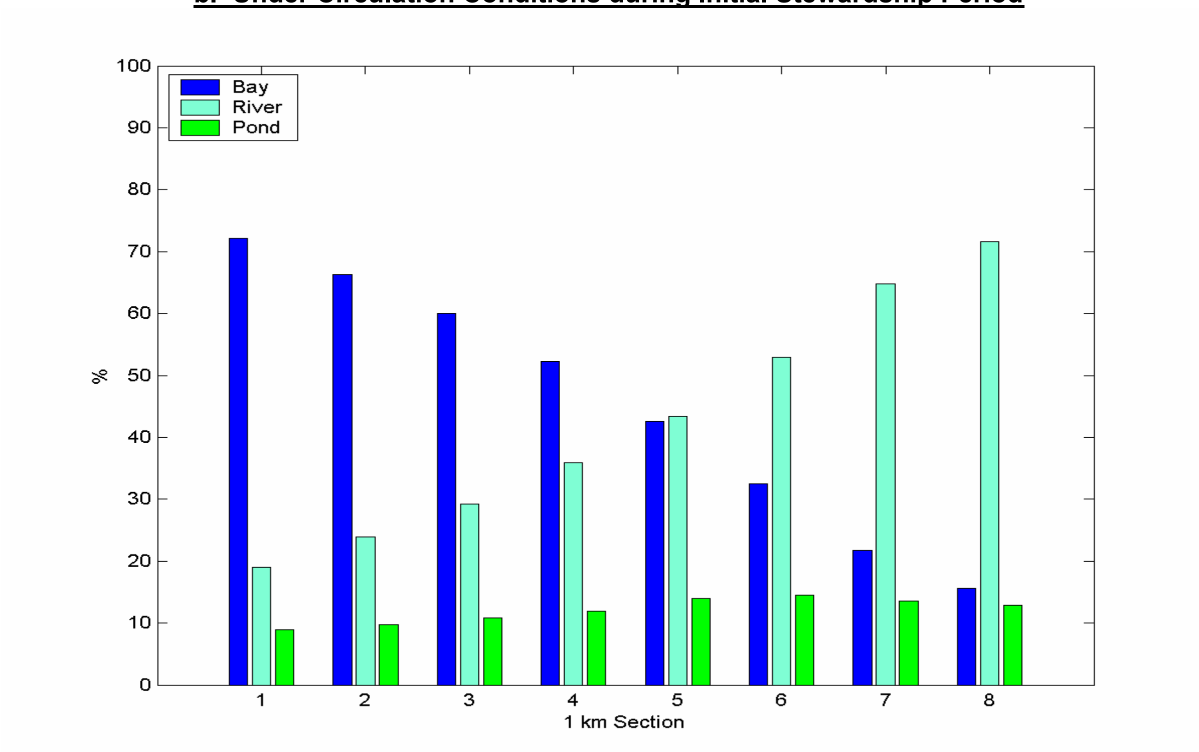
Note: Water composition computed based on volume and time averaged tracer concentration.
Predicted based on 1994-1995 weather and tidal conditions.

Figure 8. Predicted Proportions of Different Water Types along Coyote Creek in October

a. Under Existing Conditions



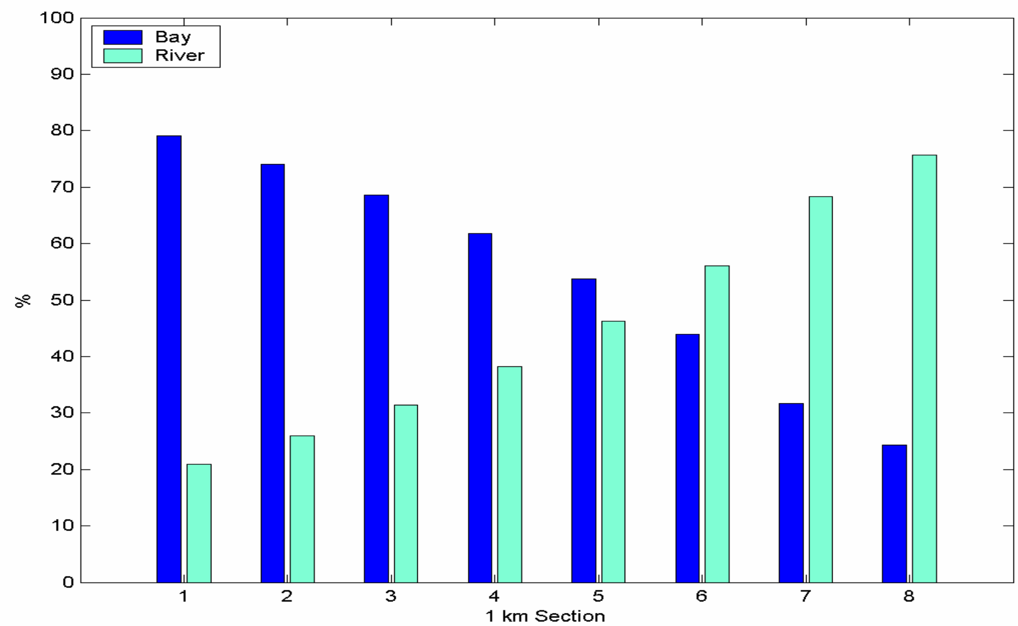
b. Under Circulation Conditions during Initial Stewardship Period



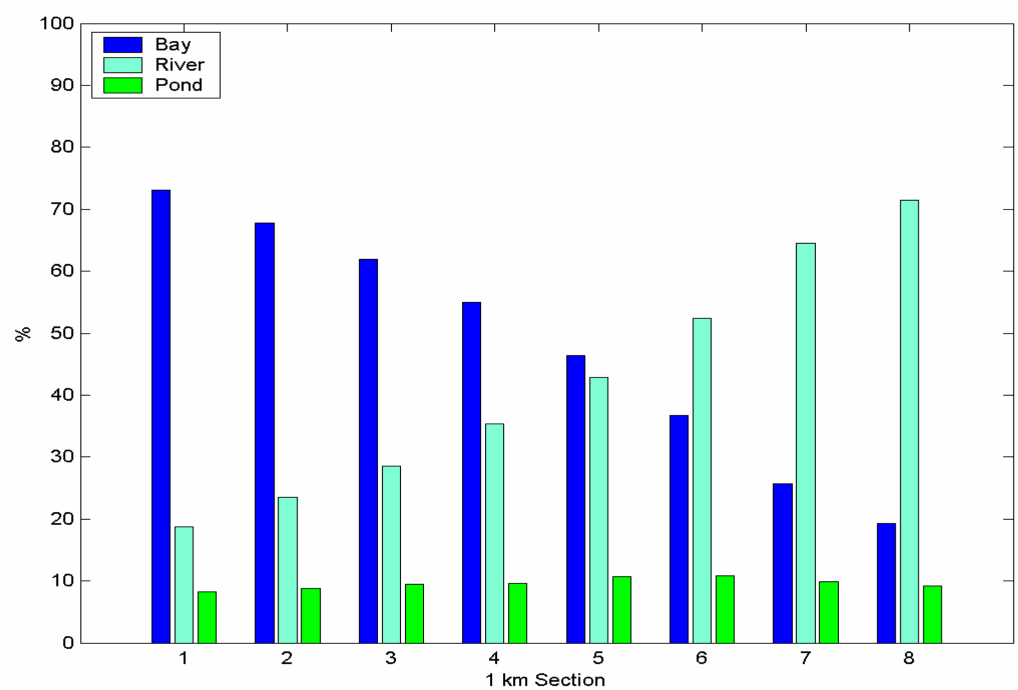
Note: Water composition computed based on volume and time averaged tracer concentration. Predicted based on 1994-1995 weather and tidal conditions.

Figure 9. Predicted Proportions of Different Water Types along Coyote Creek in November

a. Under Existing Conditions



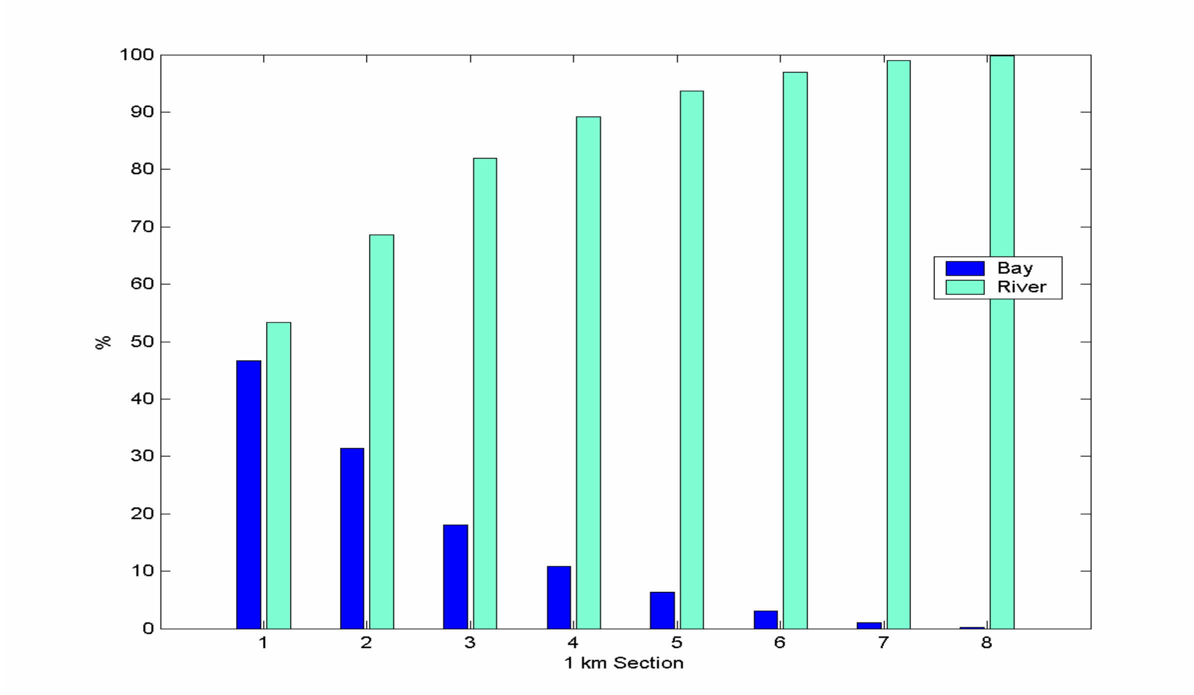
b. Under Circulation Conditions during Initial Stewardship Period



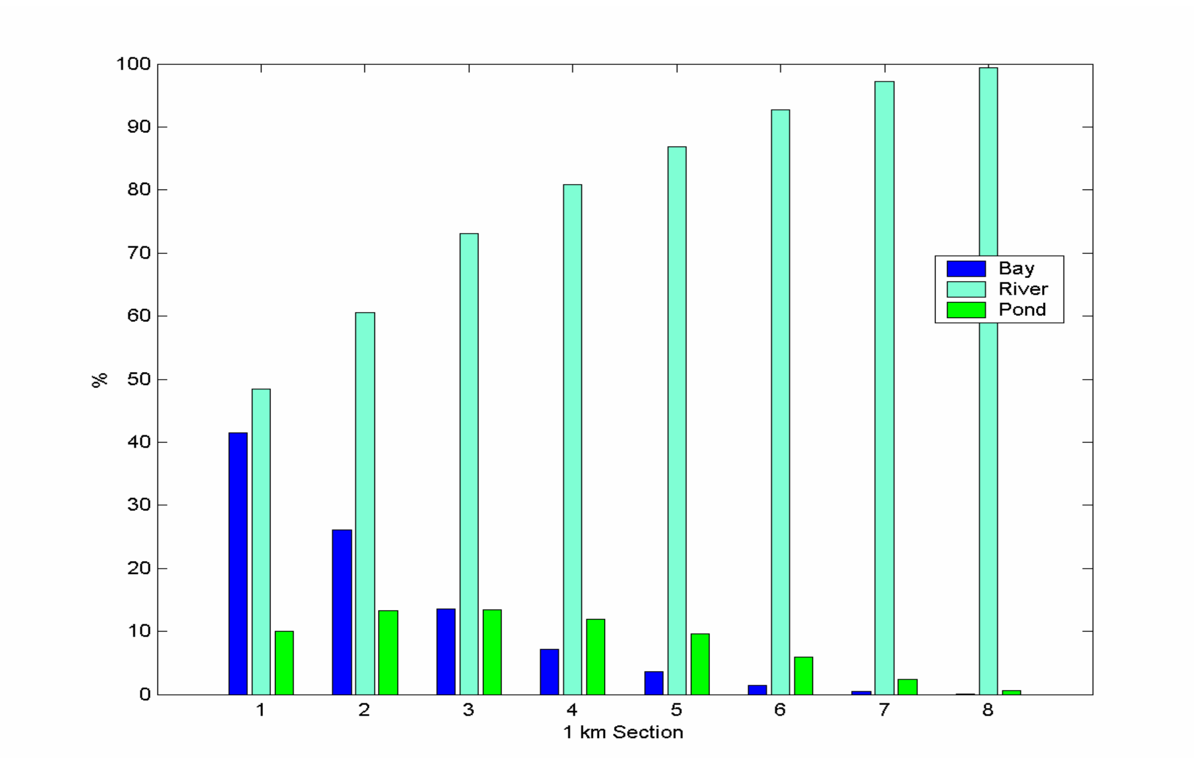
Note: Water composition computed based on volume and time averaged tracer concentration.
Predicted based on 1994-1995 weather and tidal conditions.

Figure 10. Predicted Proportions of Different Water Types along Alviso Slough in January

a. Under Existing Conditions



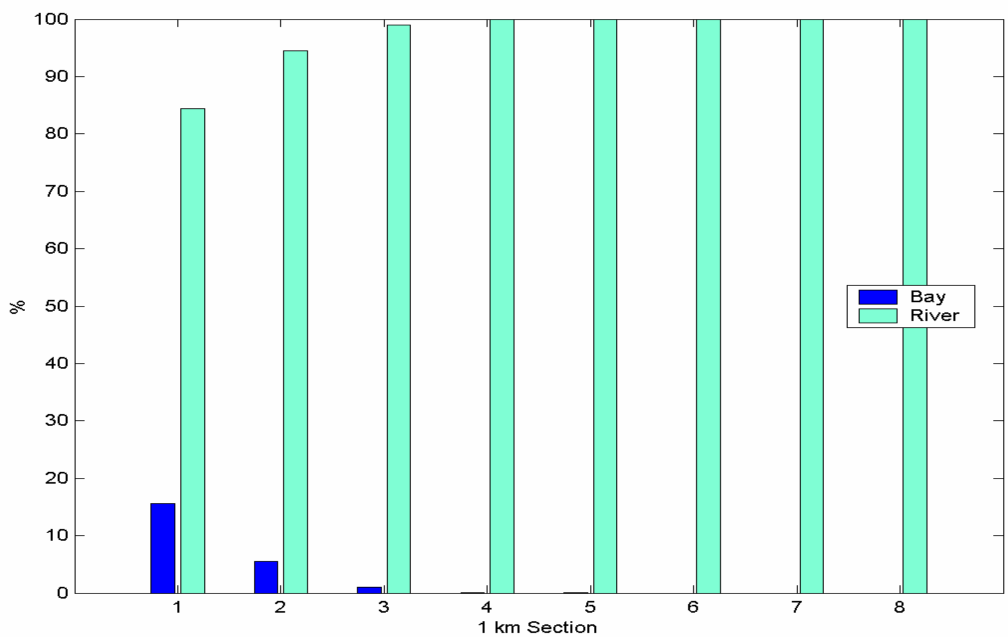
b. Under Circulation Conditions during Initial Stewardship Period



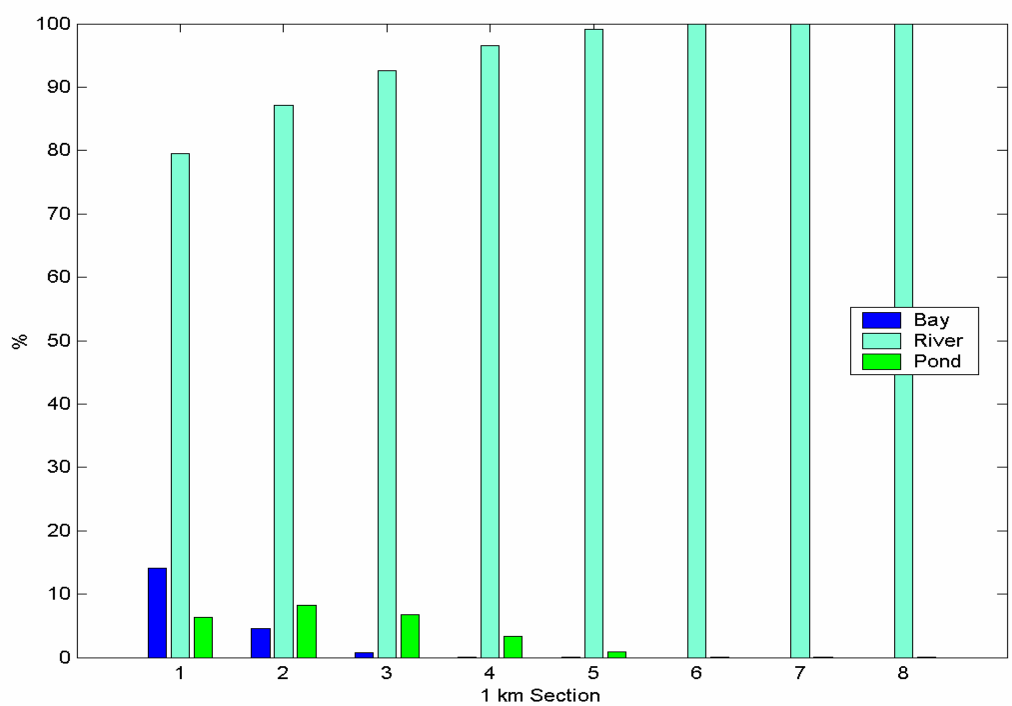
Note: Water composition computed based on volume and time averaged tracer concentration.
Predicted based on 1994-1995 weather and tidal conditions.

Figure 11. Predicted Proportions of Different Water Types along Alviso Slough in February

a. Under Existing Conditions



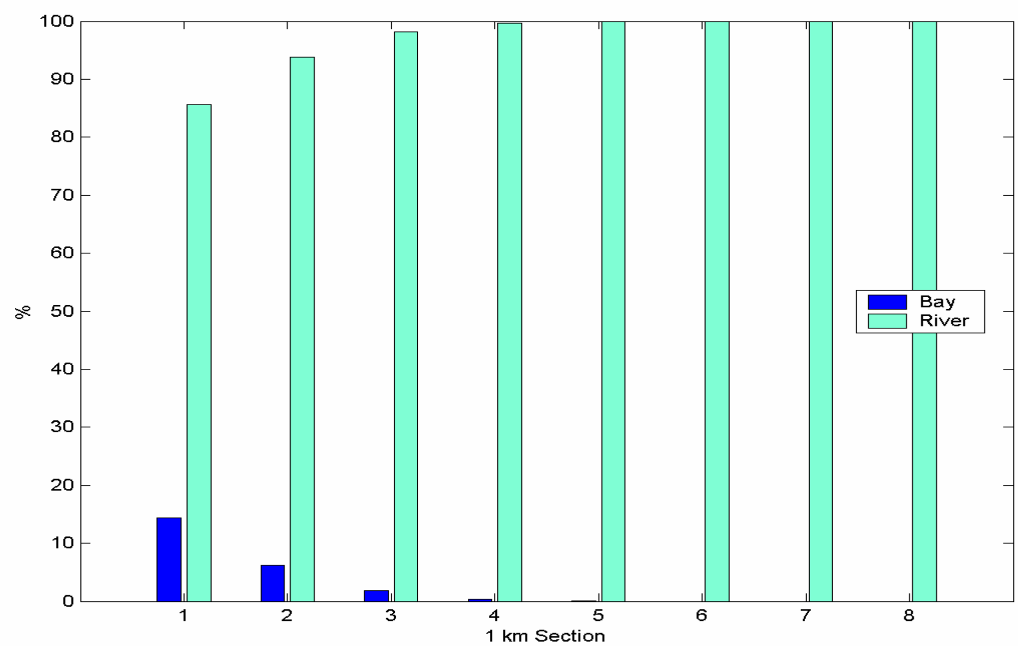
b. Under Circulation Conditions during Initial Stewardship Period



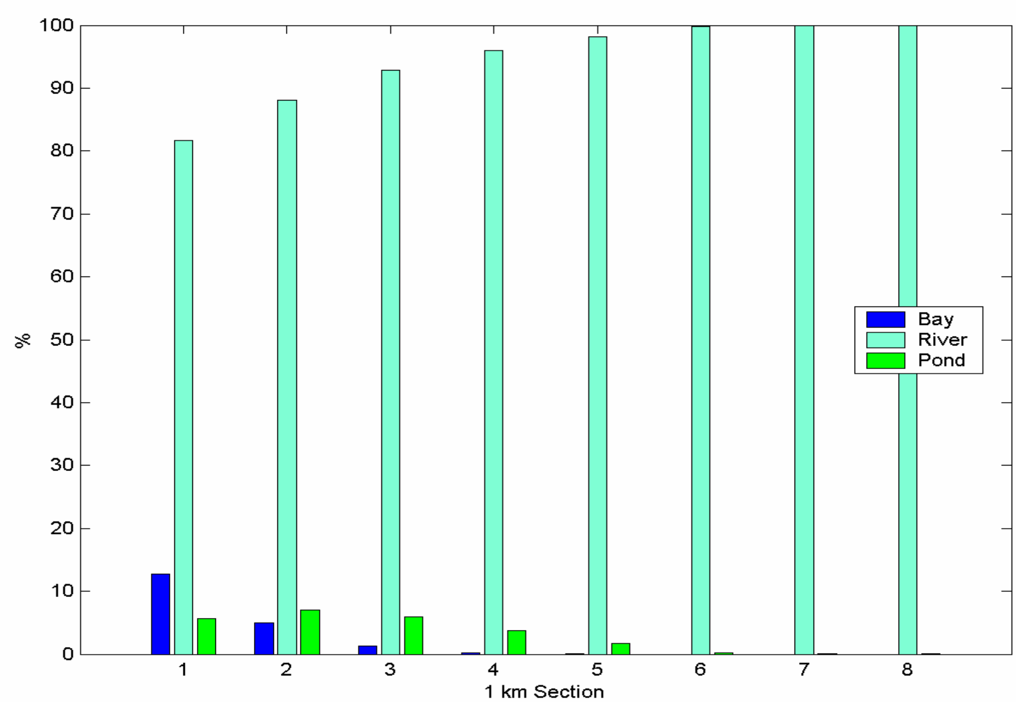
Note: Water composition computed based on volume and time averaged tracer concentration.
Predicted based on 1994-1995 weather and tidal conditions.

Figure 12. Predicted Proportions of Different Water Types along Alviso Slough in March

a. Under Existing Conditions



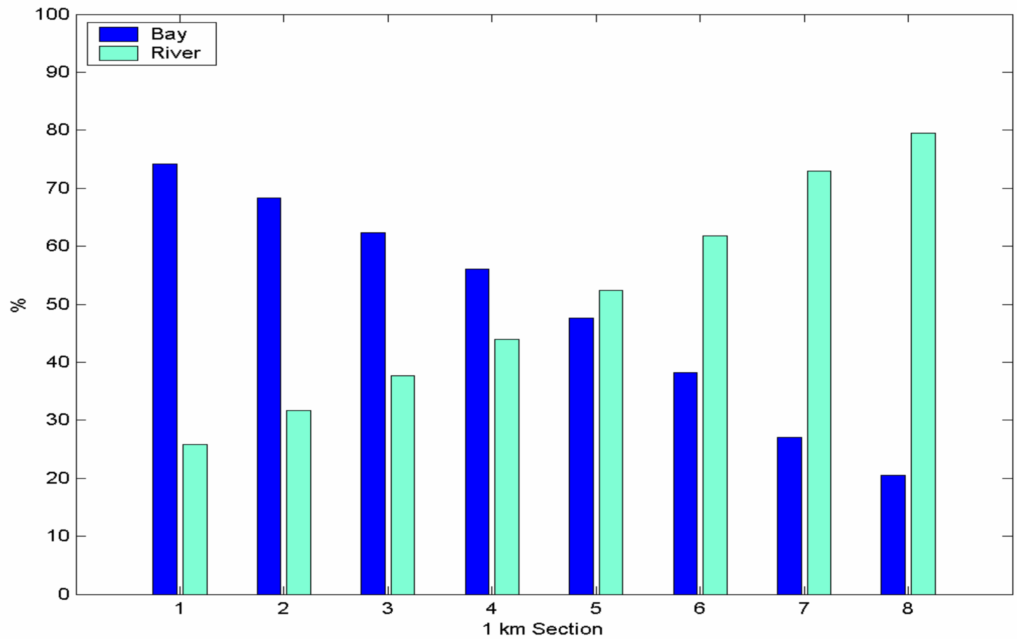
b. Under Circulation Conditions during Initial Stewardship Period



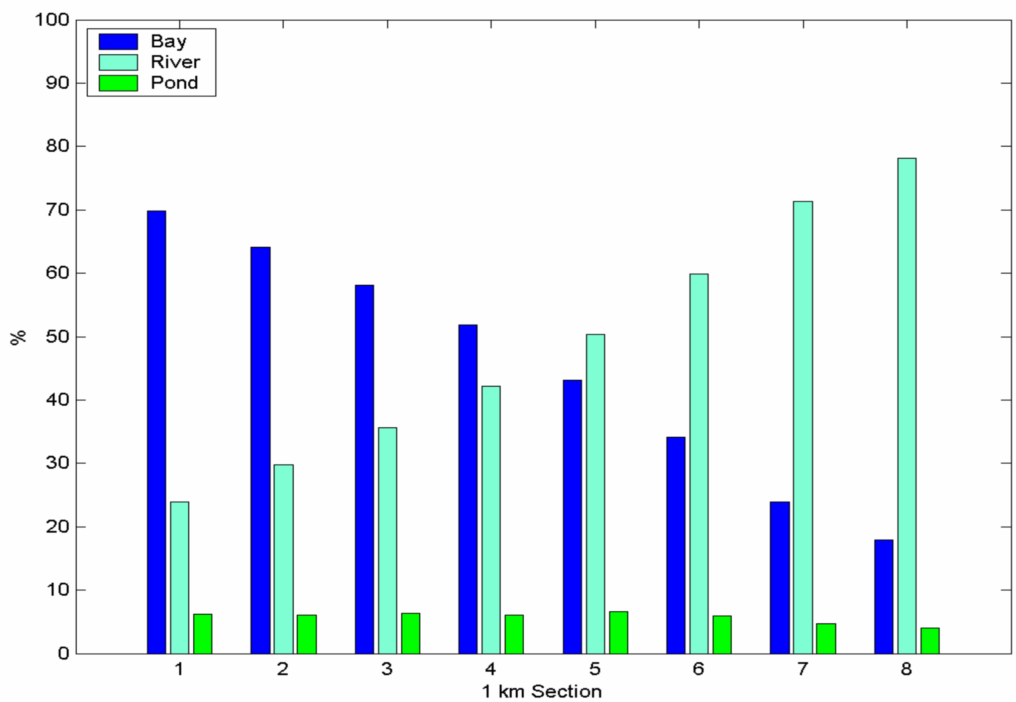
Note: Water composition computed based on volume and time averaged tracer concentration.
Predicted based on 1994-1995 weather and tidal conditions.

Figure 13. Predicted Proportions of Different Water Types along Coyote Creek in January

a. Under Existing Conditions



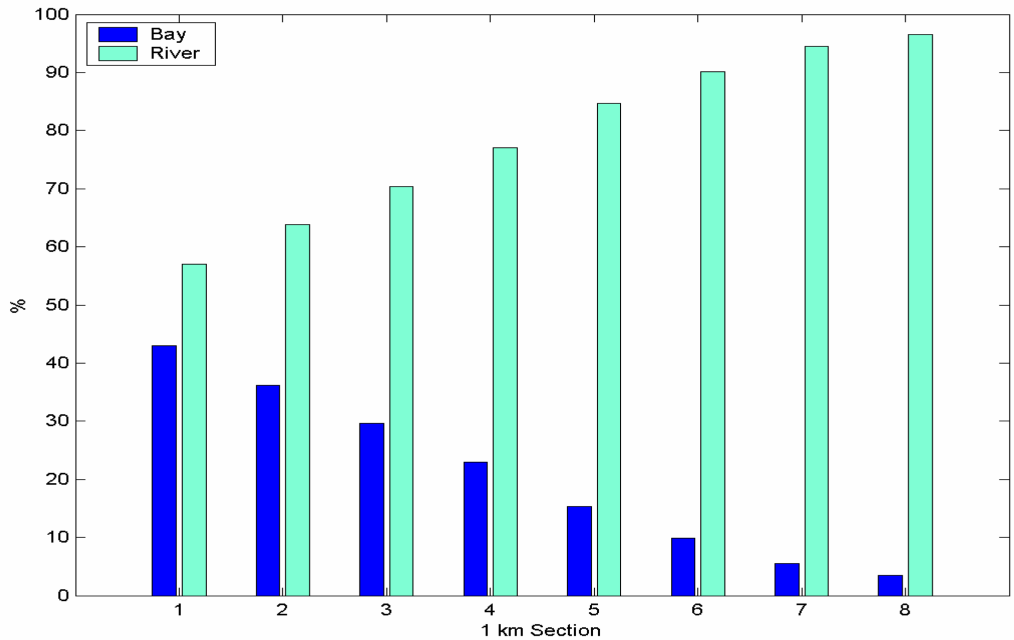
b. Under Circulation Conditions during Initial Stewardship Period



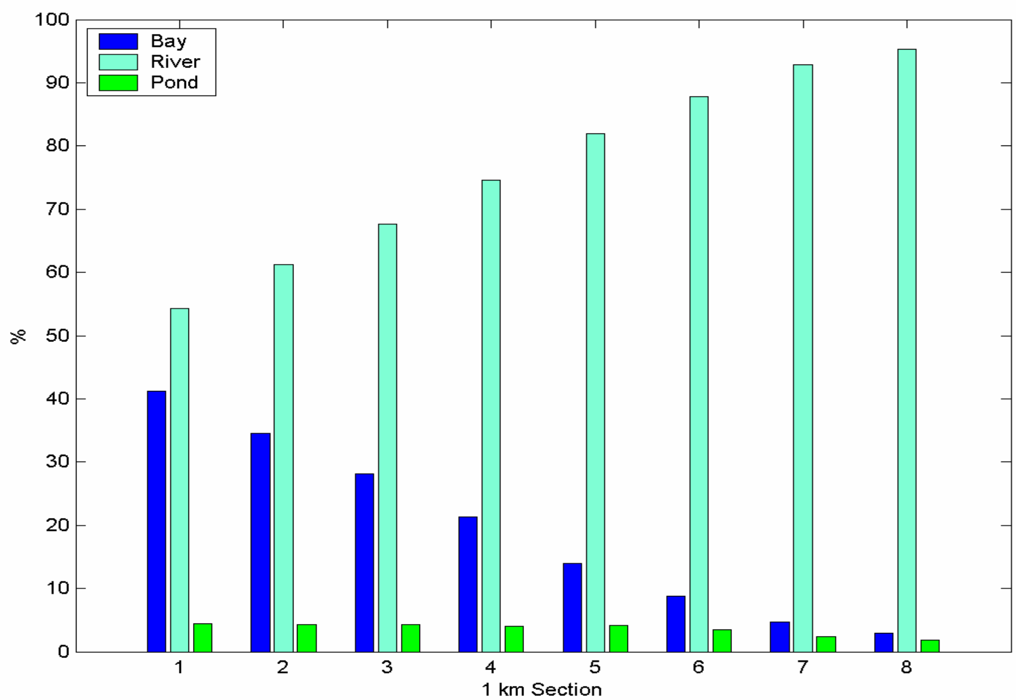
Note: Water composition computed based on volume and time averaged tracer concentration.
Predicted based on 1994-1995 weather and tidal conditions.

Figure 14. Predicted Proportions of Different Water Types along Coyote Creek in February

a. Under Existing Conditions



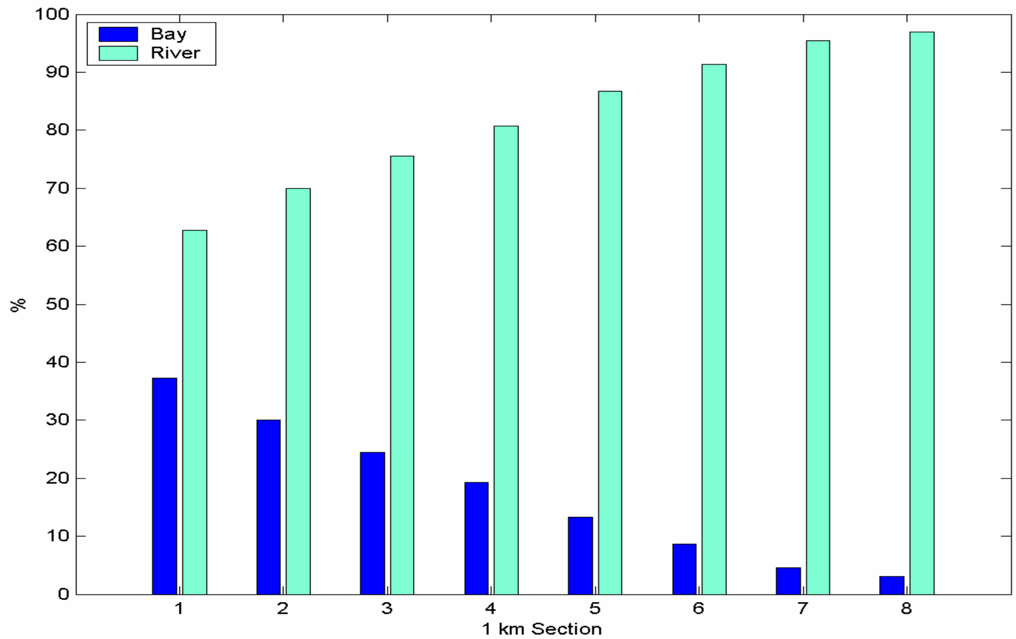
b. Under Circulation Conditions during Initial Stewardship Period



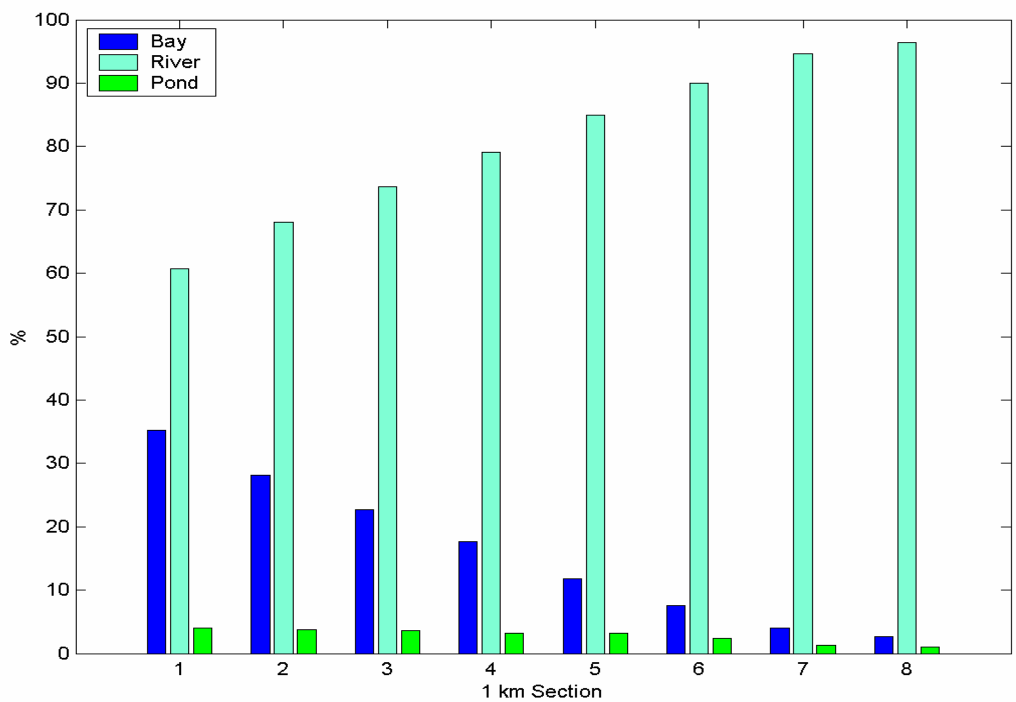
Note: Water composition computed based on volume and time averaged tracer concentration.
Predicted based on 1994-1995 weather and tidal conditions.

Figure 15. Predicted Proportions of Different Water Types along Coyote Creek in March

a. Under Existing Conditions



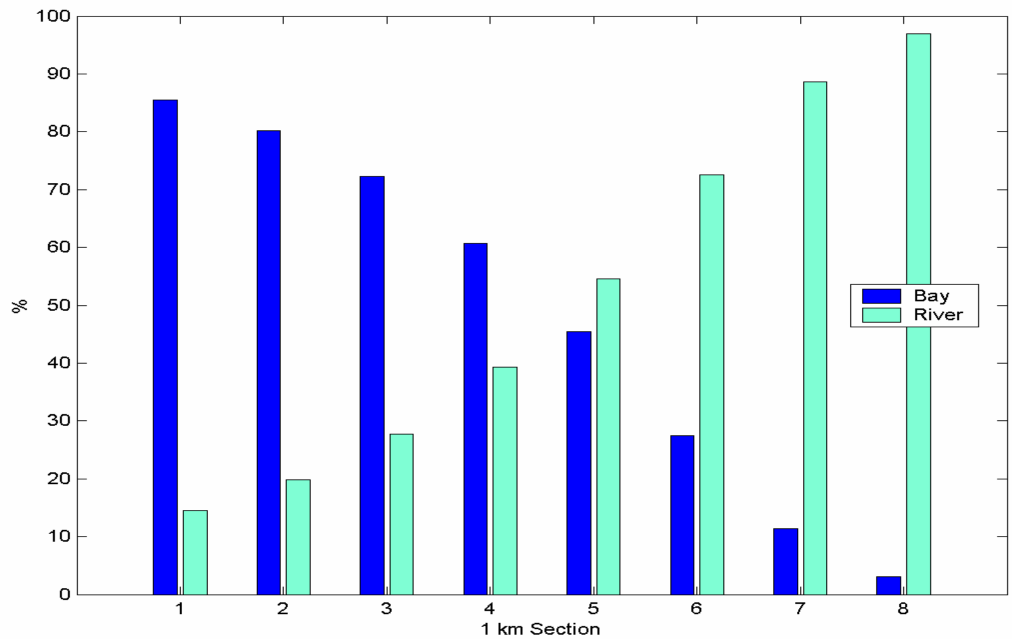
b. Under Circulation Conditions during Initial Stewardship Period



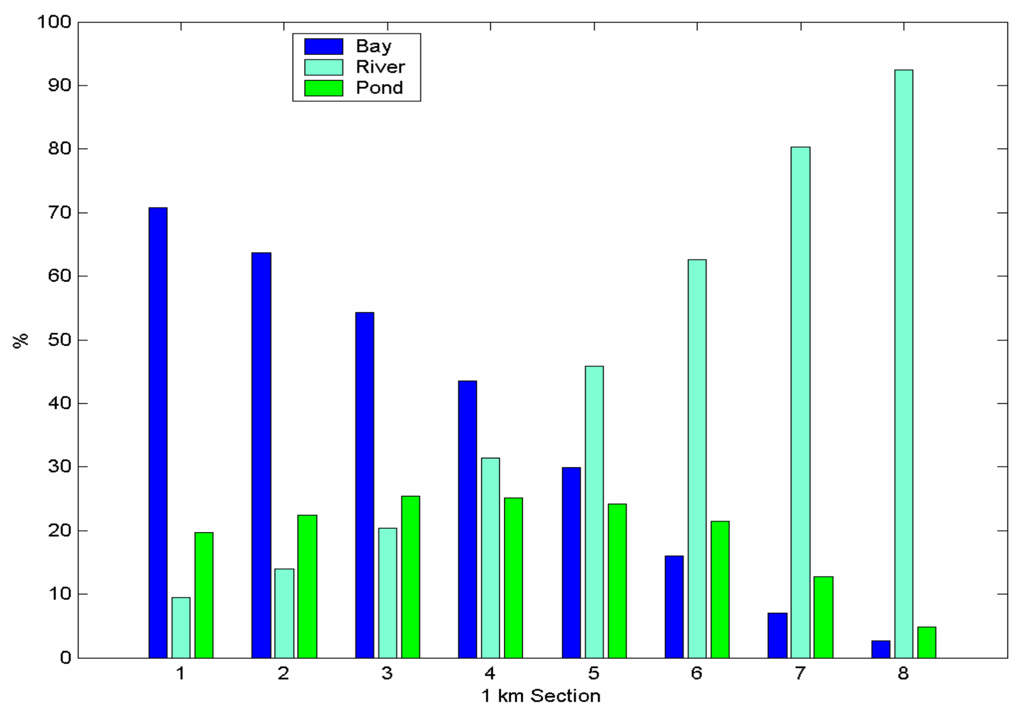
Note: Water composition computed based on volume and time averaged tracer concentration.
Predicted based on 1994-1995 weather and tidal conditions.

Figure 16. Predicted Proportions of Different Water Types along Alameda Flood Control Channel in January

a. Under Existing Conditions



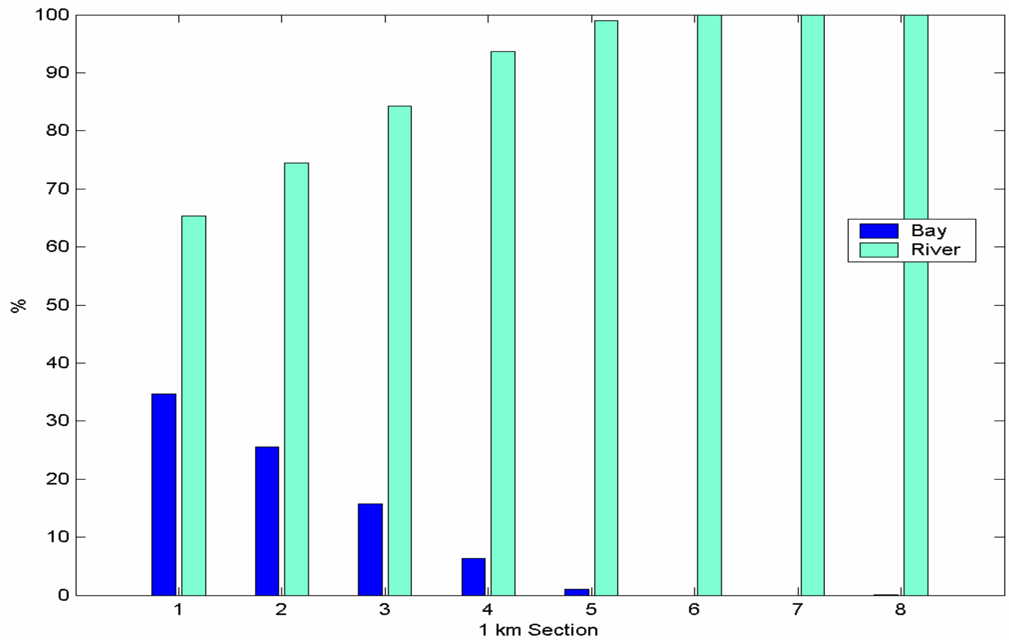
b. Under Circulation Conditions during Initial Stewardship Period



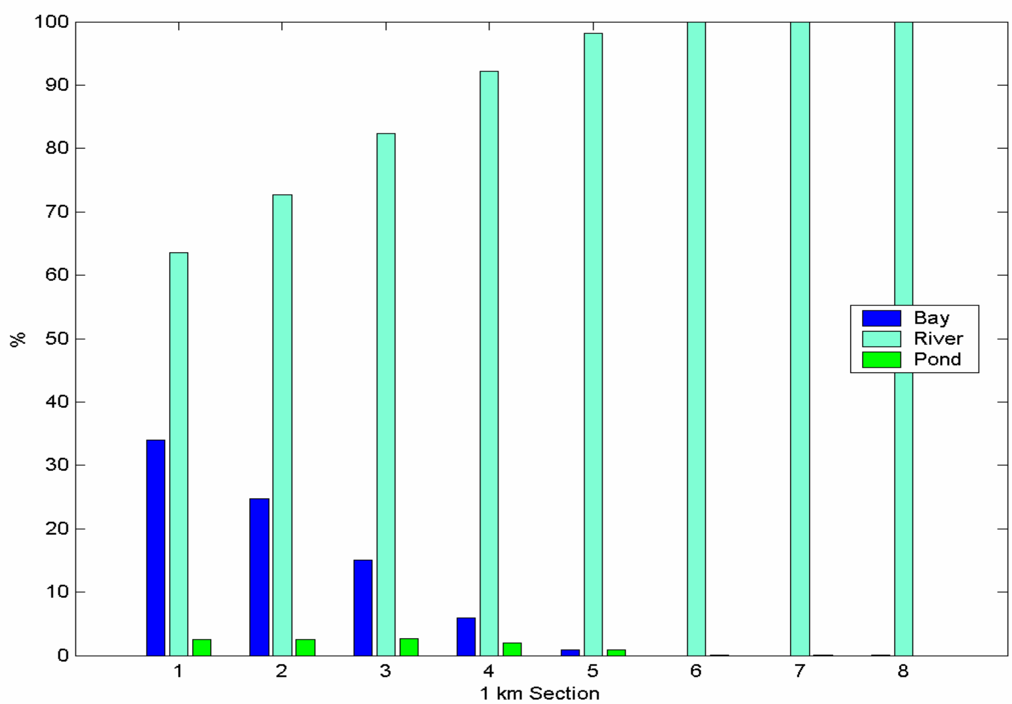
Note: Water composition computed based on volume and time averaged tracer concentration.
Predicted based on 1994-1995 weather and tidal conditions.

Figure 17. Predicted Proportions of Different Water Types along Alameda Flood Control Channel in February

a. Under Existing Conditions



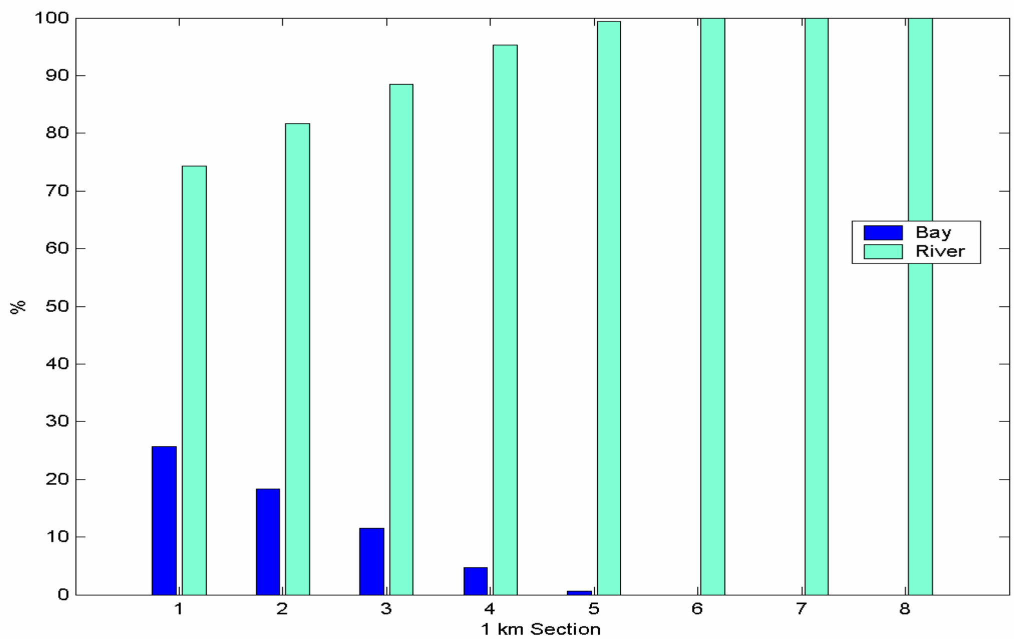
b. Under Circulation Conditions during Initial Stewardship Period



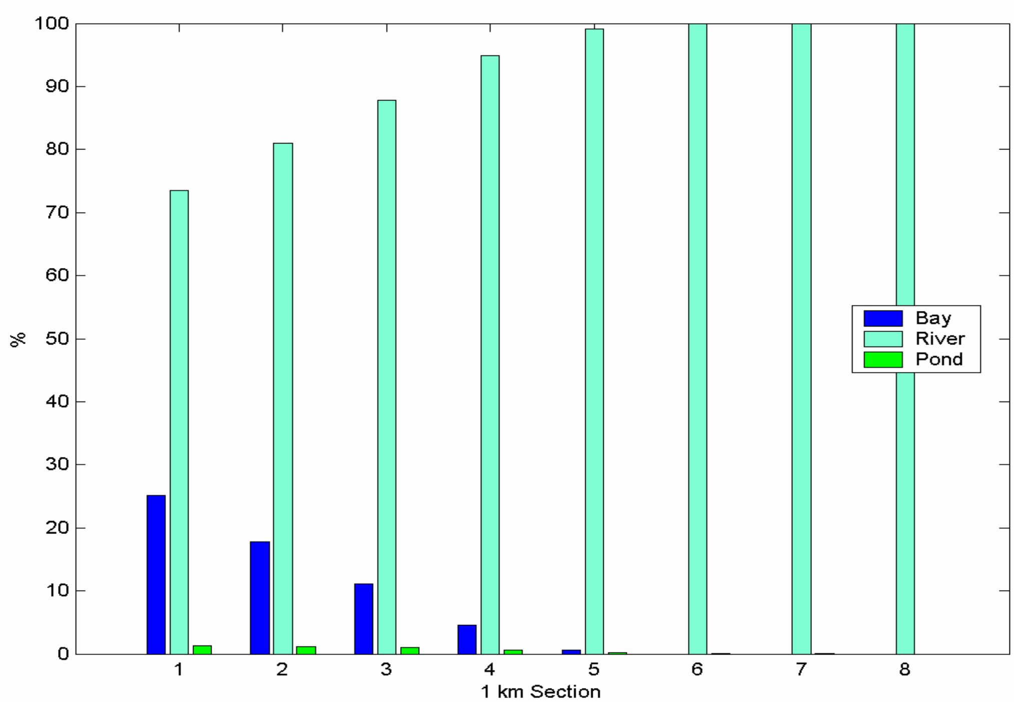
Note: Water composition computed based on volume and time averaged tracer concentration. Predicted based on 1994-1995 weather and tidal conditions.

Figure 18. Predicted Proportions of Different Water Types along Alameda Flood Control Channel in March

a. Under Existing Conditions



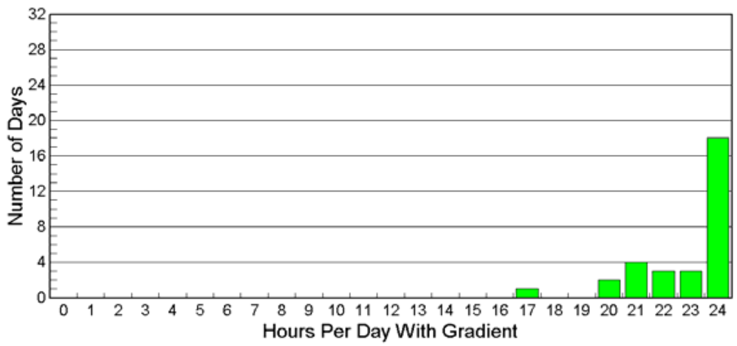
b. Under Circulation Conditions during Initial Stewardship Period



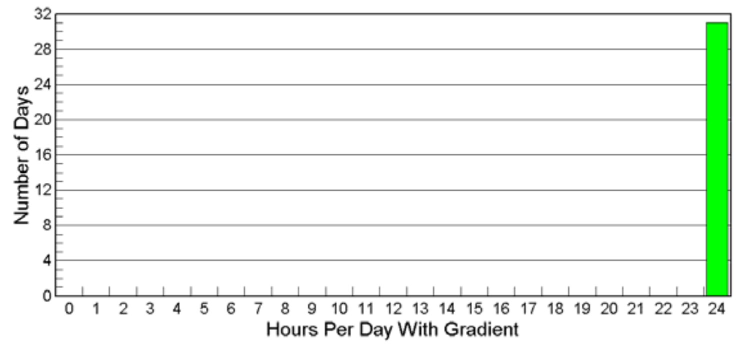
Note: Water composition computed based on volume and time averaged tracer concentration.
Predicted based on 1994-1995 weather and tidal conditions.

Figure 19. Predicted Presence of a Continuous Salinity Gradient in Alameda Flood Control Channel during Initial Stewardship Period in Winter Months when Adult Steelhead Trout would Migrate Upstream (if barriers were not present)

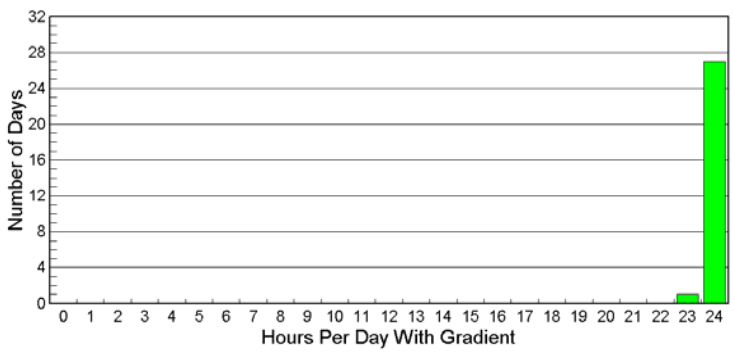
January: based on a 1 ppt Gradient Reversal Threshold



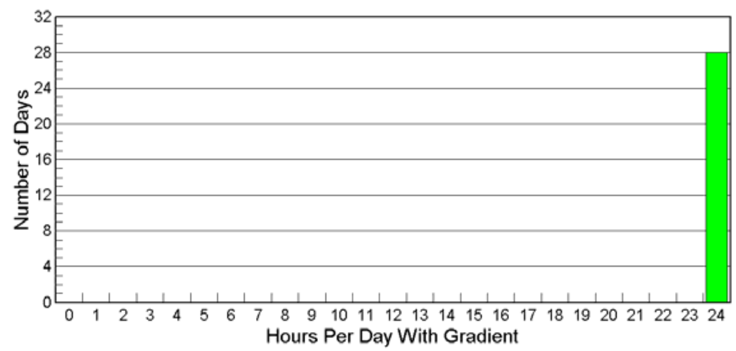
January: based on a 3 ppt Gradient Reversal Threshold



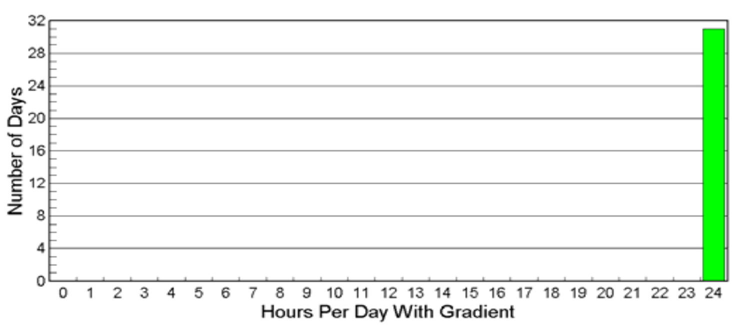
February: based on a 1 ppt Gradient Reversal Threshold



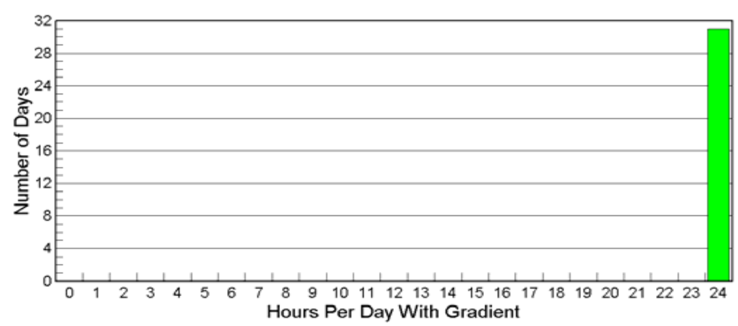
February: based on a 3 ppt Gradient Reversal Threshold



March: based on a 1 ppt Gradient Reversal Threshold



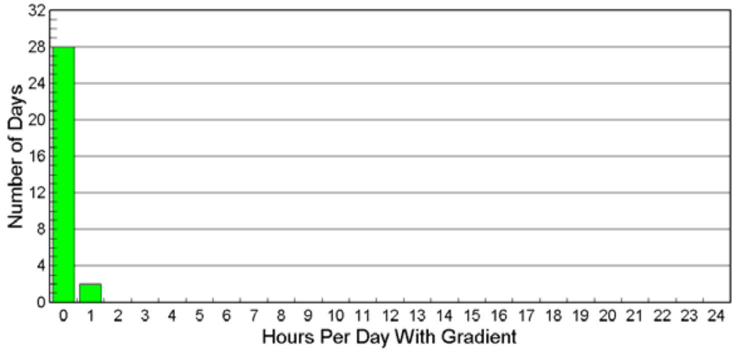
March: based on a 3 ppt Gradient Reversal Threshold



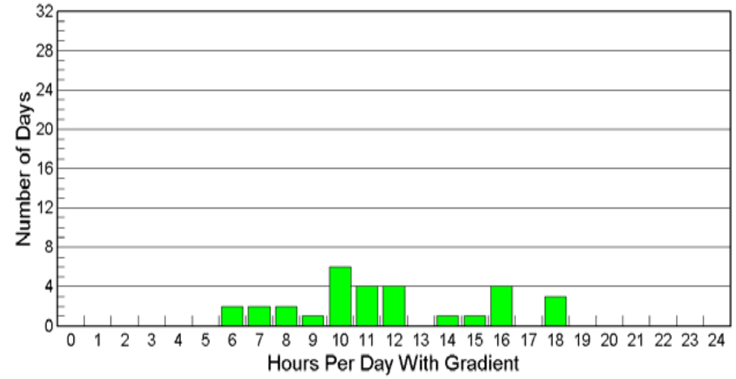
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction.
Predictions based on 1994-1995 weather and tidal conditions.

Figure 20. Predicted Presence of a Continuous Salinity Gradient in Alviso Slough during Initial Stewardship Period in Fall Months when Adult Chinook Salmon Migrate Upstream

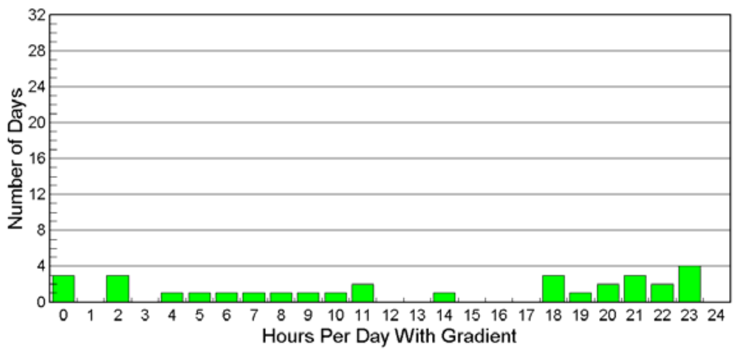
September: Based on a 1 ppt Gradient Reversal Threshold



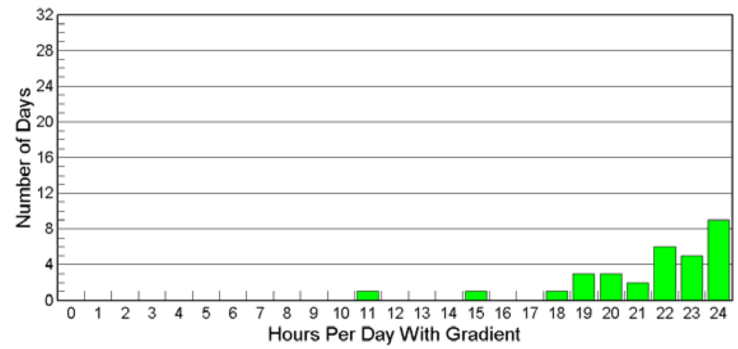
September: based on a 3 ppt Gradient Reversal Threshold



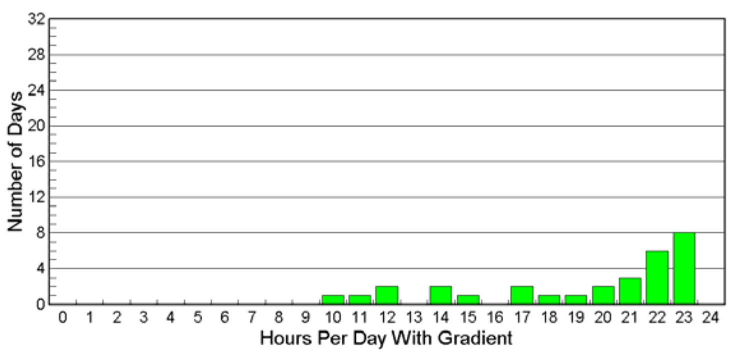
October: based on a 1 ppt Gradient Reversal Threshold



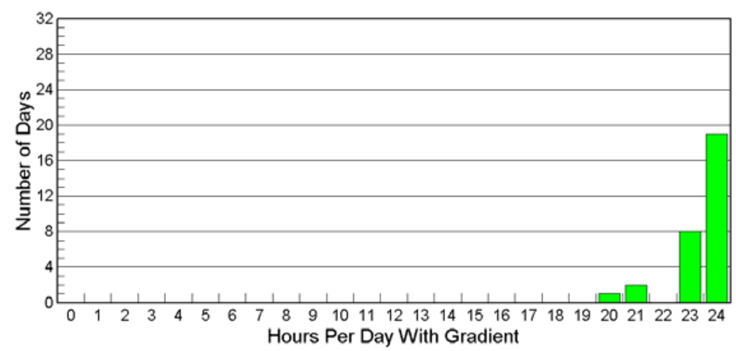
October: based on a 3 ppt Gradient Reversal Threshold



November: based on a 1 ppt Gradient Reversal Threshold



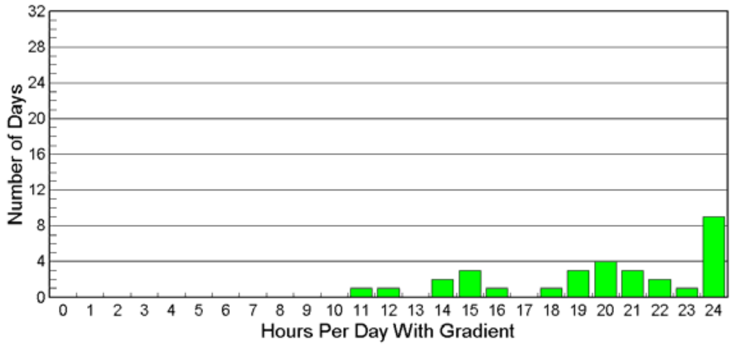
November: based on a 3 ppt Gradient Reversal Threshold



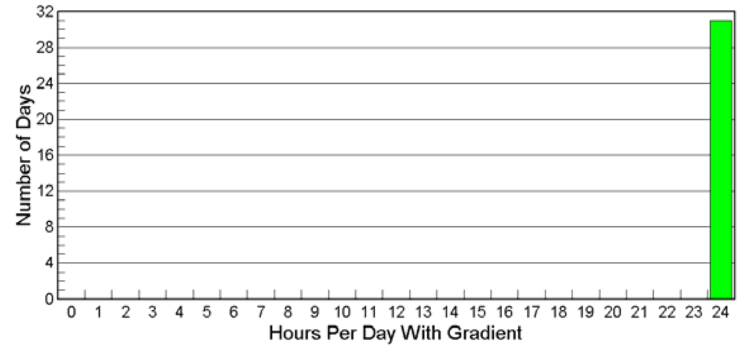
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction.
Predictions based on 1994-1995 weather and tidal conditions.

Figure 21. Predicted Presence of a Continuous Salinity Gradient in Alviso Slough during Initial Stewardship Period in Winter Months when Adult Steelhead Trout Migrate Upstream

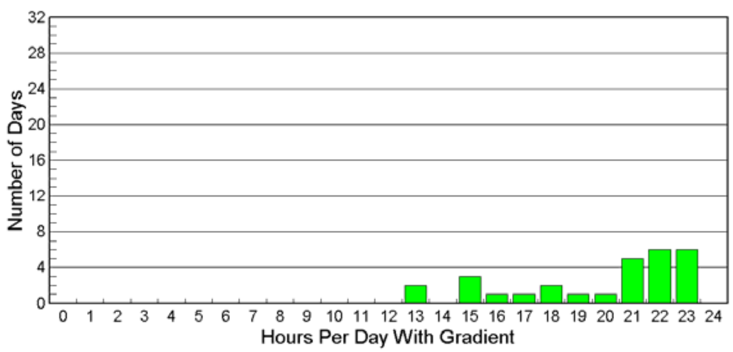
January: based on a 1 ppt Gradient Reversal Threshold



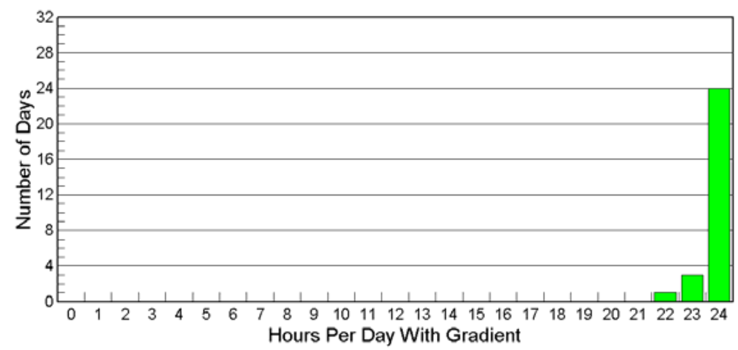
January: based on a 3 ppt Gradient Reversal Threshold



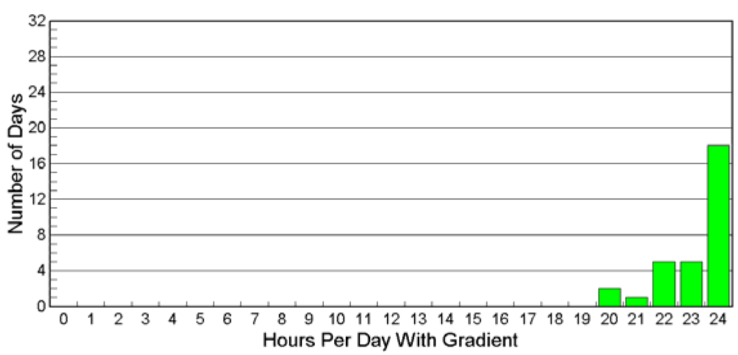
February: based on a 1 ppt Gradient Reversal Threshold



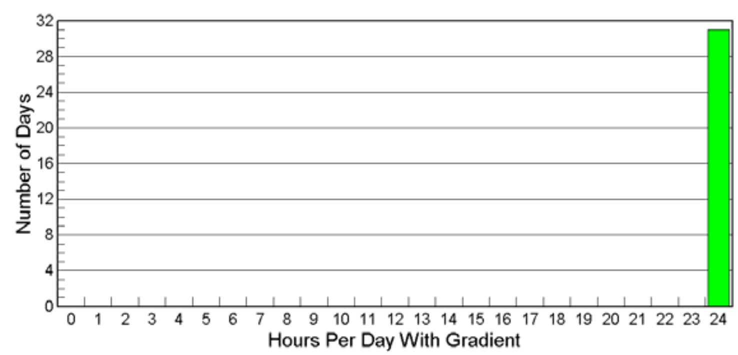
February: based on a 3 ppt Gradient Reversal Threshold



March: based on a 1 ppt Gradient Reversal Threshold



March: based on a 3 ppt Gradient Reversal Threshold

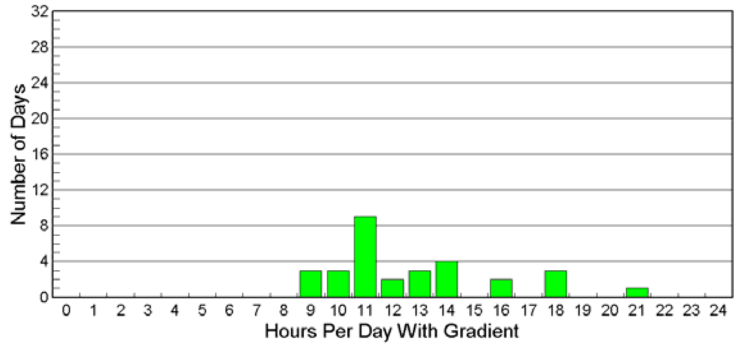


Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction.

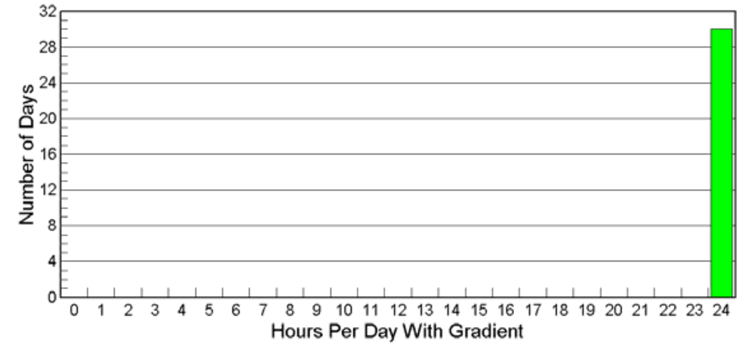
Predictions based on 1994-1995 weather and tidal conditions.

Figure 22. Predicted Presence of a Continuous Salinity Gradient in Coyote Creek during Initial Stewardship Period in Fall Months when Adult Chinook Salmon Migrate Upstream

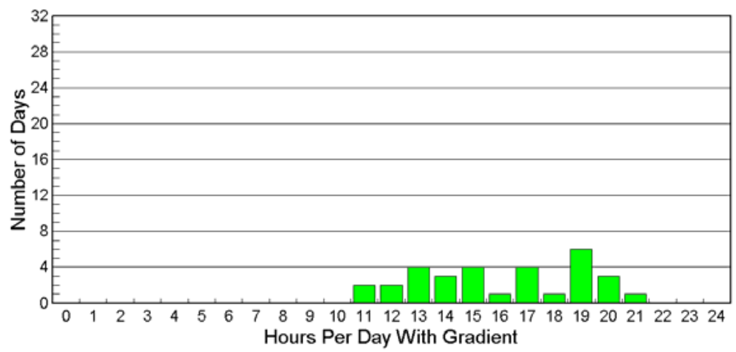
September: based on a 1 ppt Gradient Reversal Threshold



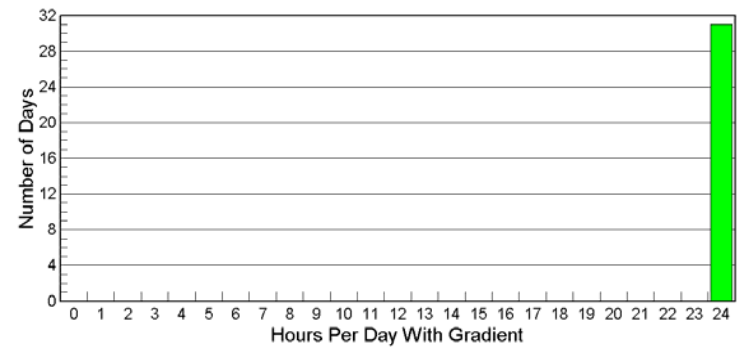
September: based on a 3 ppt Gradient Reversal Threshold



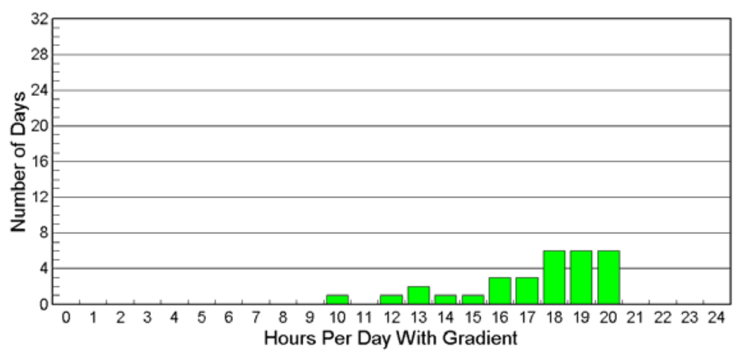
October: based on a 1 ppt Gradient Reversal Threshold



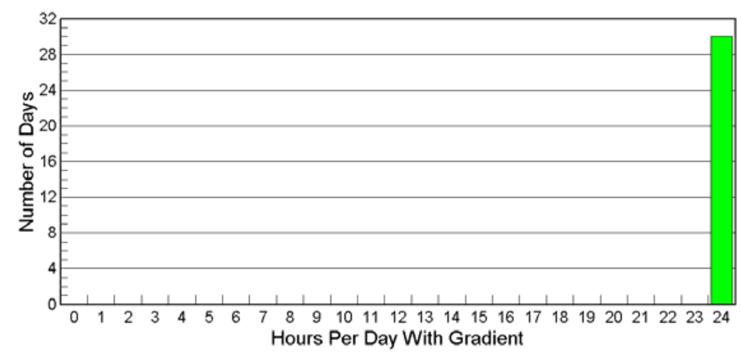
October: based on a 3 ppt Gradient Reversal Threshold



November: based on a 1 ppt Gradient Reversal Threshold



November: based on a 3 ppt Gradient Reversal Threshold

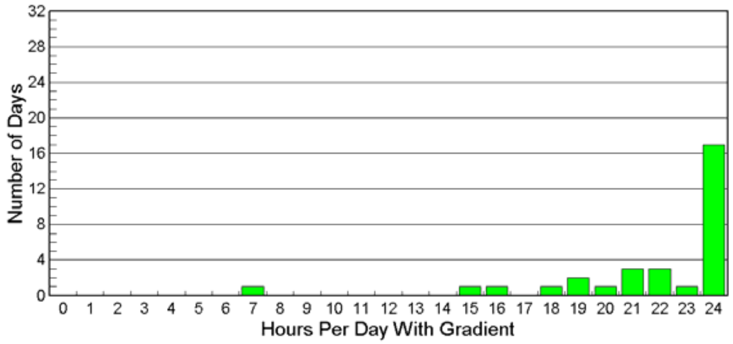


Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction.

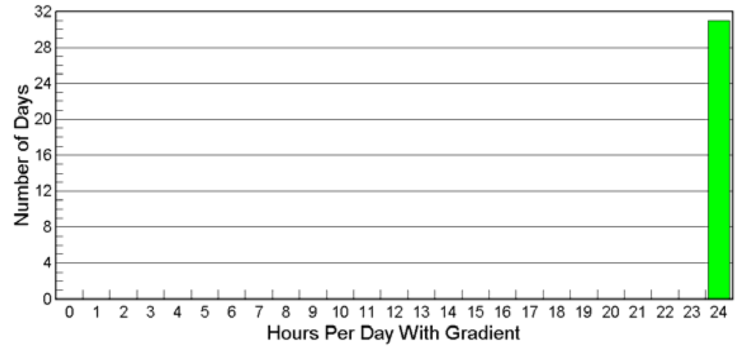
Predictions based on 1994-1995 weather and tidal conditions.

Figure 23. Predicted Presence of a Continuous Salinity Gradient in Coyote Creek during Initial Stewardship Period in Winter Months when Adult Steelhead Trout Migrate Upstream

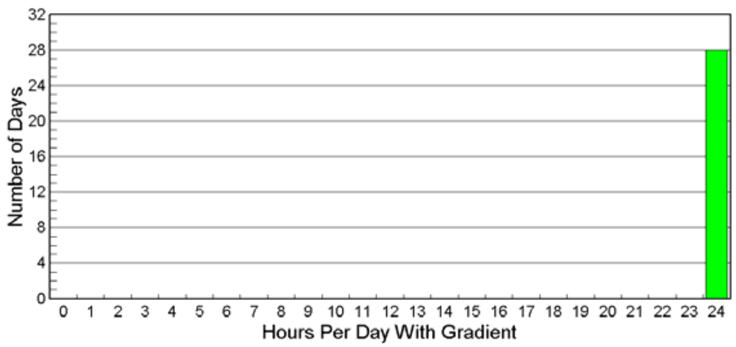
January: based on a 1 ppt Gradient Reversal Threshold



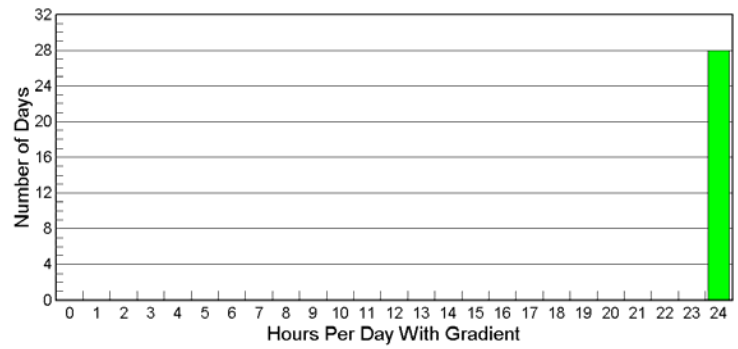
January: based on a 3 ppt Gradient Reversal Threshold



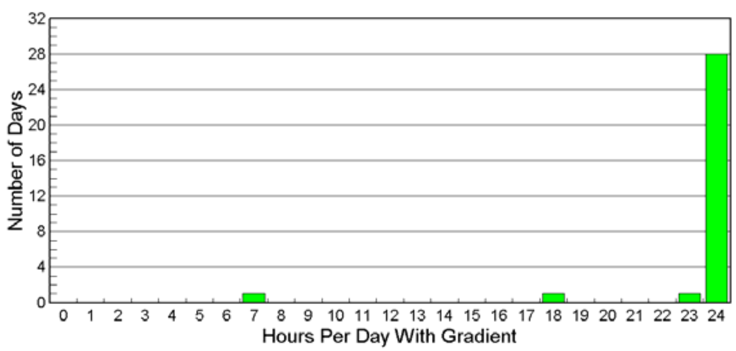
February: based on a 1 ppt Gradient Reversal Threshold



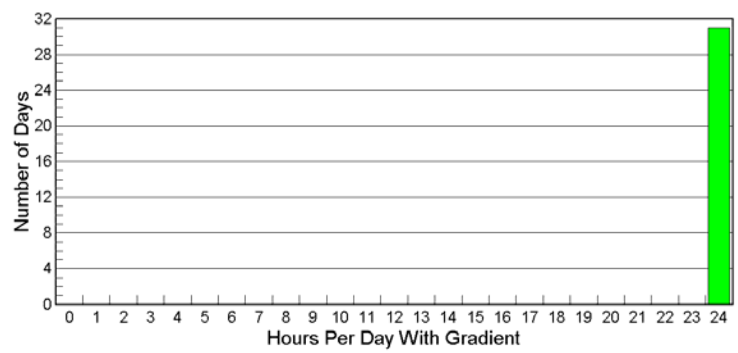
February: based on a 3 ppt Gradient Reversal Threshold



March: based on a 1 ppt Gradient Reversal Threshold



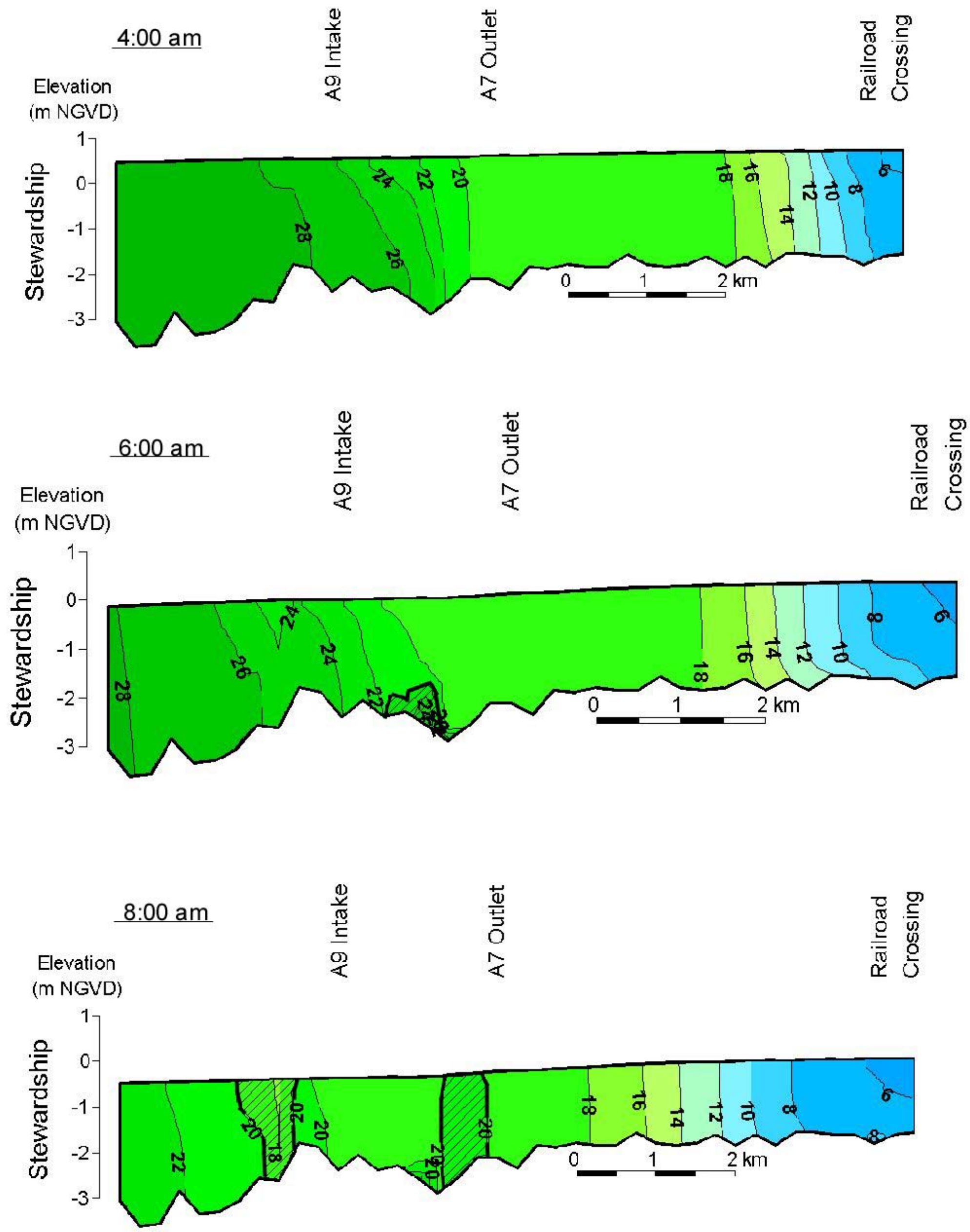
March: based on a 3 ppt Gradient Reversal Threshold



Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction.

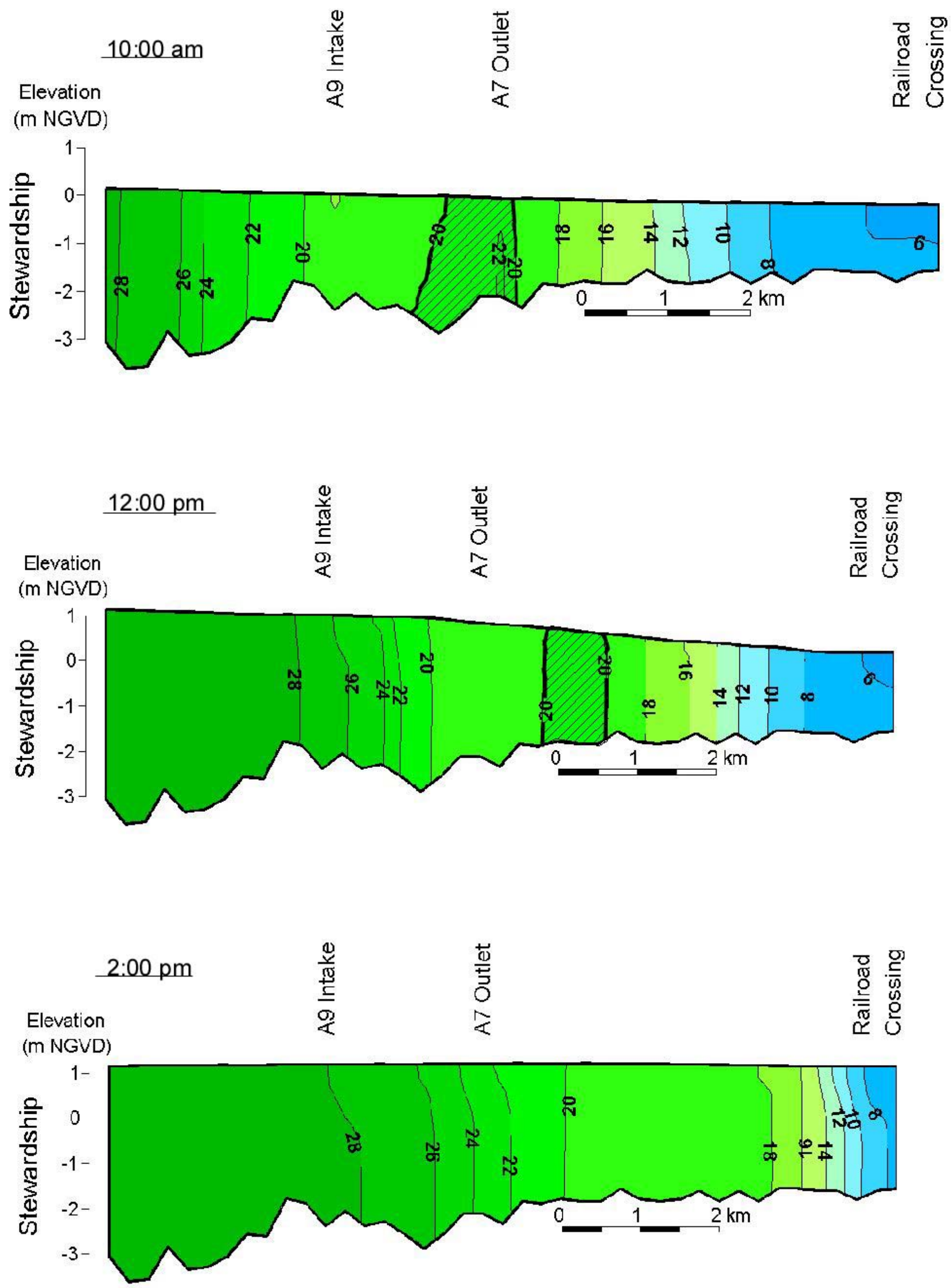
Predictions based on 1994-1995 weather and tidal conditions.

Figure 24. Example of a Predicted Salinity Reversal in Alviso Slough in Late October under Initial Stewardship Period Conditions
(Page 1 of 2)



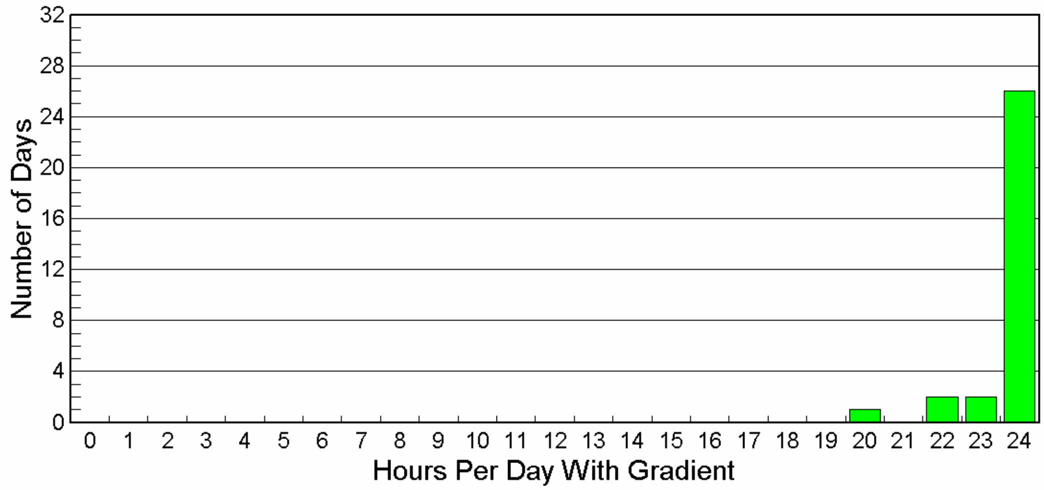
Note: Location of predicted reversals designated by hatched area. Salinity profiles computed along a longitudinal transect in the hydrodynamic model. Predictions based on 1994 weather and tidal conditions.

Figure 24 Cont'd. Example of a Predicted Salinity Reversal in Alviso Slough in Late October under Initial Stewardship Period Conditions (Page 2 of 2)

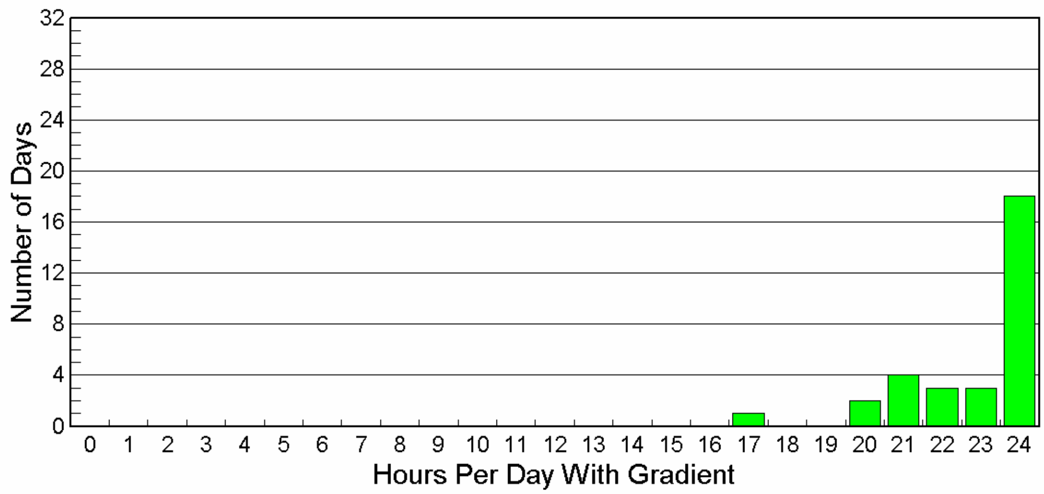


Note: Location of predicted reversals designated by hatched area. Salinity profiles computed along a longitudinal transect in the hydrodynamic model. Predictions based on 1994 weather and tidal conditions.

Existing Conditions



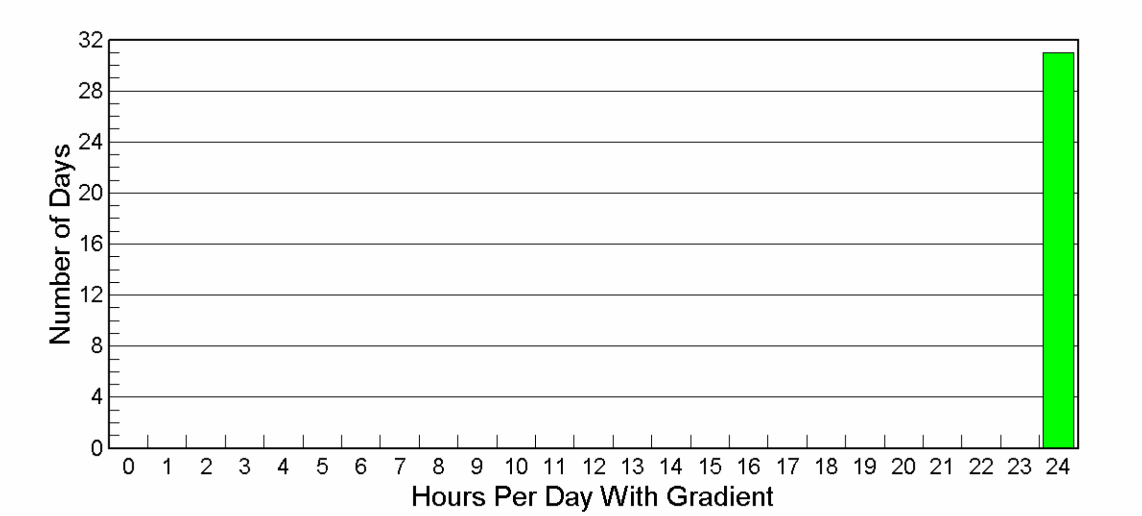
Initial Stewardship Conditions



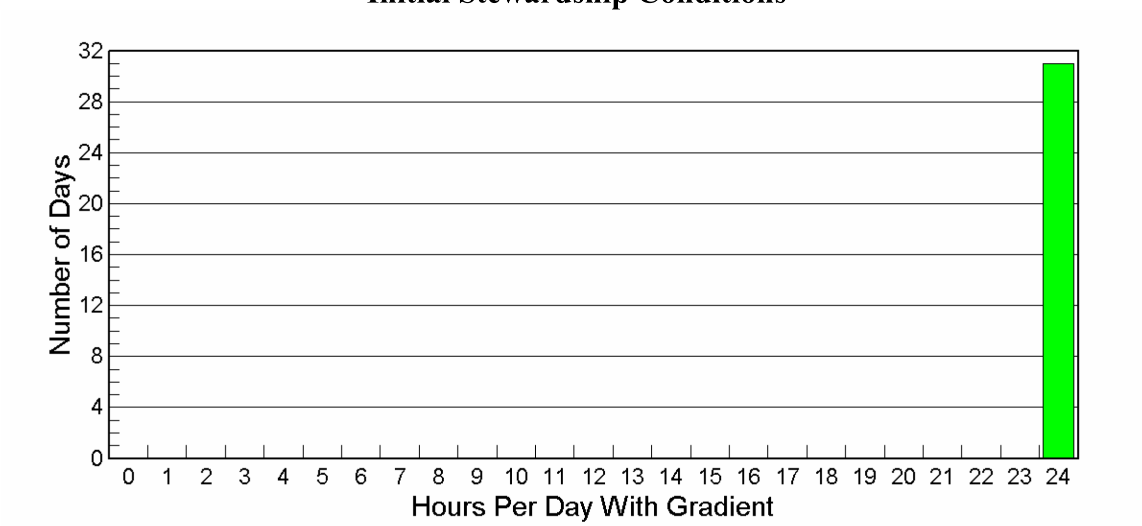
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction. Predicted based on 1994-1995 weather and tidal conditions.

Appendix A. Figure 1. Predicted Presence of a Salinity Gradient in the **Alameda Flood Control Channel** using a **1 ppt Gradient Reversal Threshold**. Comparison of Gradients Predicted for “Existing Conditions” and “Initial Stewardship Conditions” in **January**.

Existing Conditions



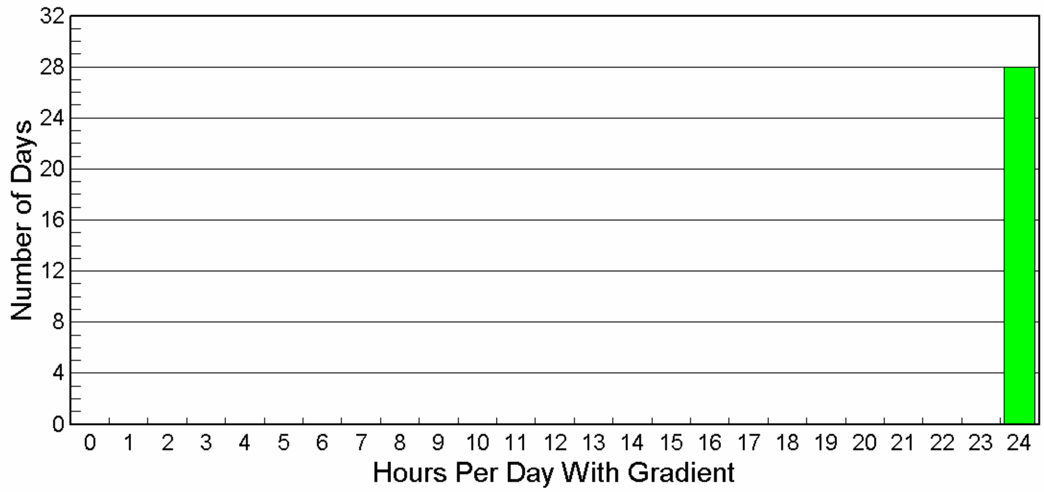
Initial Stewardship Conditions



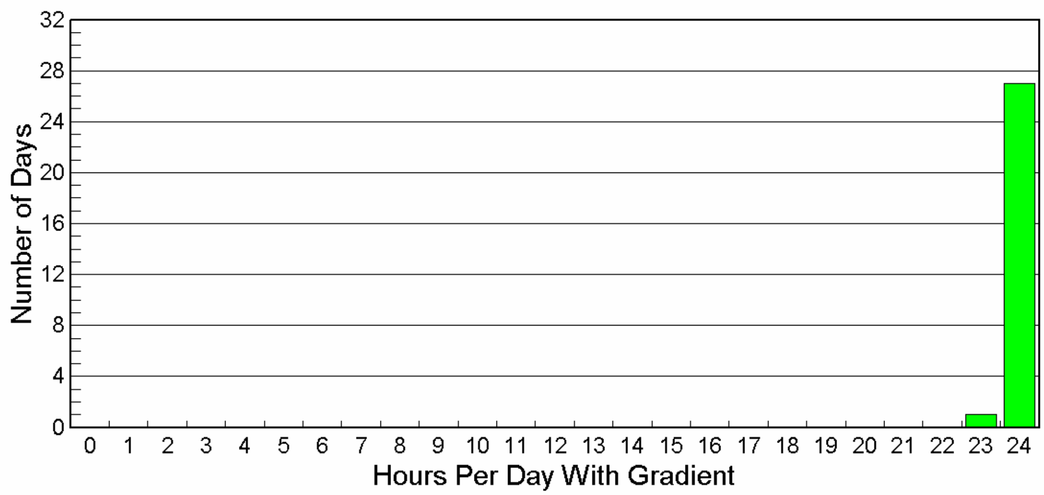
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction. Predicted based on 1994-1995 weather and tidal conditions.

Appendix A. Figure 2. Predicted Presence of a Salinity Gradient in the **Alameda Flood Control Channel** using a **3 ppt Gradient Reversal Threshold**. Comparison of Gradients Predicted for "Existing Conditions" and "Initial Stewardship Conditions" in **January**.

Existing Conditions



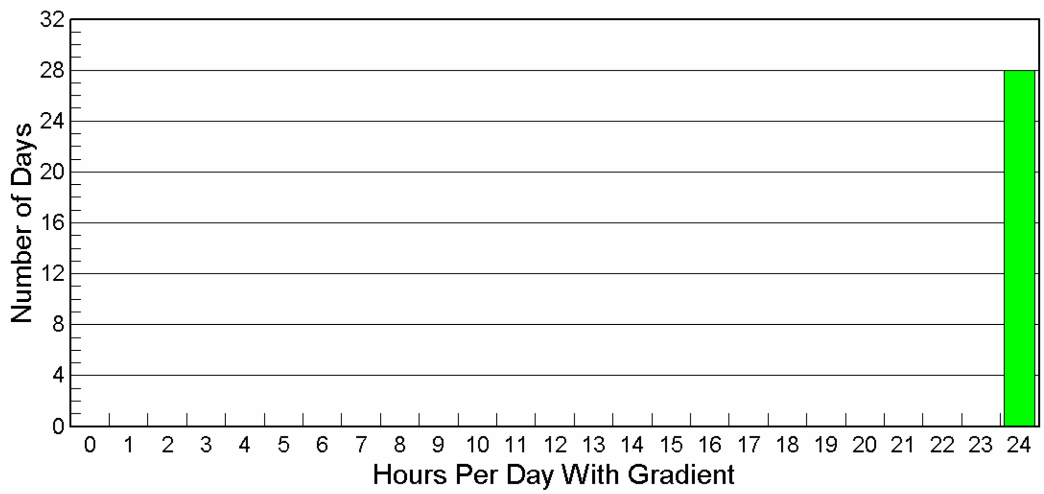
Initial Stewardship Conditions



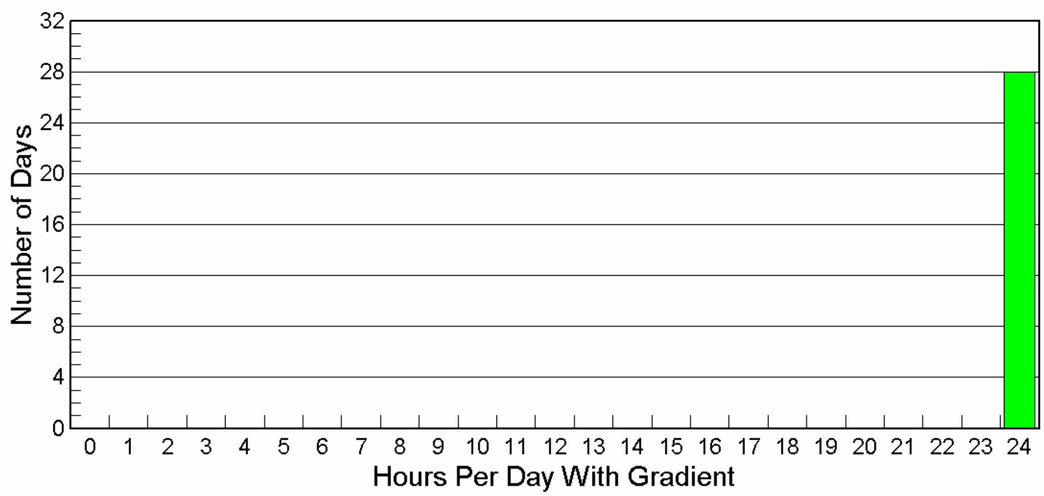
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction. Predicted based on 1994-1995 weather and tidal conditions.

Appendix A. Figure 3. Predicted Presence of a Salinity Gradient in the **Alameda Flood Control Channel** using a **1 ppt Gradient Reversal Threshold**. Comparison of Gradients Predicted for "Existing Conditions" and "Initial Stewardship Conditions" in **February**.

Existing Conditions



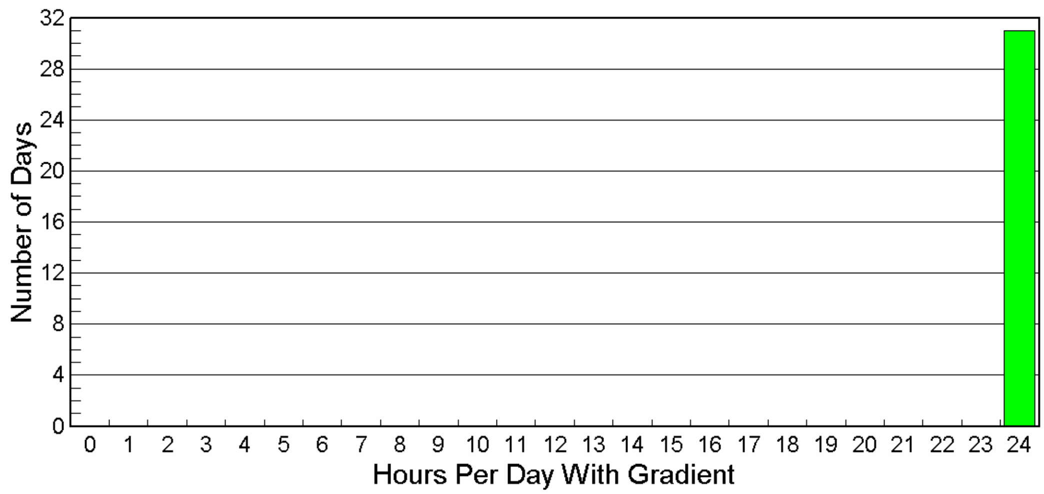
Initial Stewardship Conditions



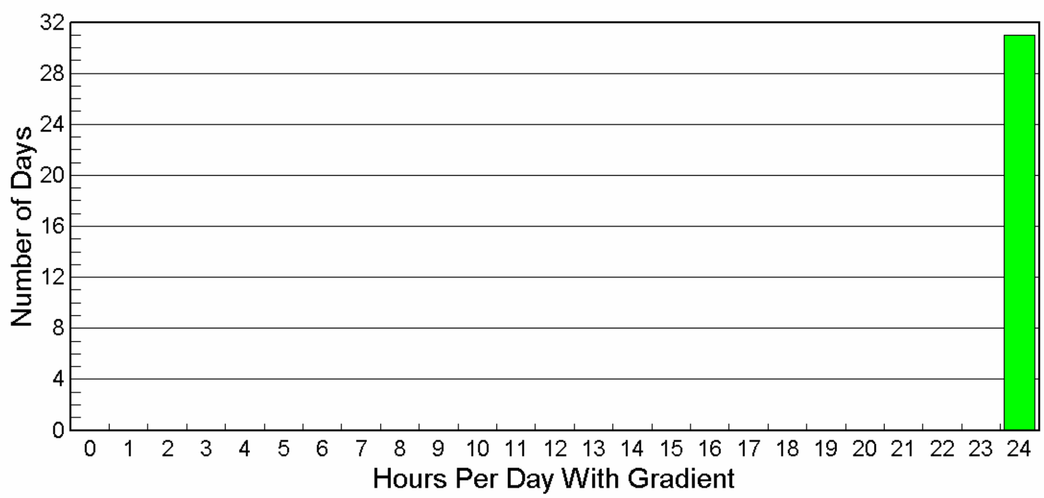
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction. Predicted based on 1994-1995 weather and tidal conditions.

Appendix A. Figure 4. Predicted Presence of a Salinity Gradient in the **Alameda Flood Control Channel** using a **3 ppt Gradient Reversal Threshold**. Comparison of Gradients Predicted for “Existing Conditions” and “Initial Stewardship Conditions” in **February**.

Existing Conditions



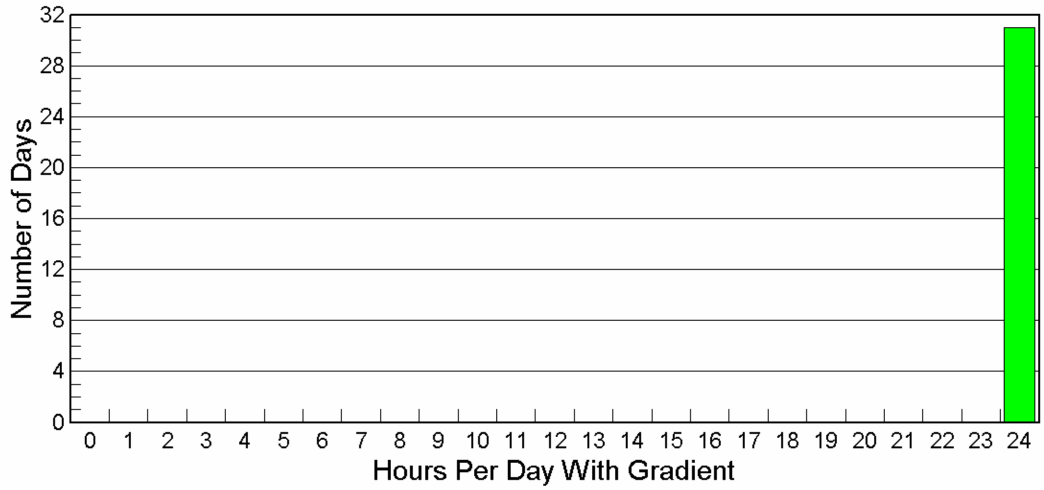
Initial Stewardship Conditions



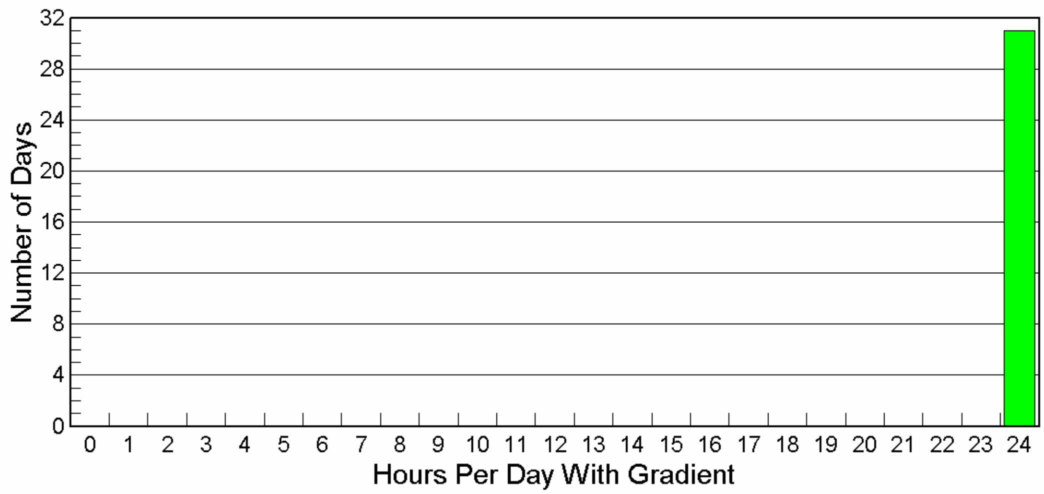
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction. Predicted based on 1994-1995 weather and tidal conditions.

Appendix A. Figure 5. Predicted Presence of a Salinity Gradient in the **Alameda Flood Control Channel** using a **1 ppt Gradient Reversal Threshold**. Comparison of Gradients Predicted for “Existing Conditions” and “Initial Stewardship Conditions” in **March**.

Existing Conditions



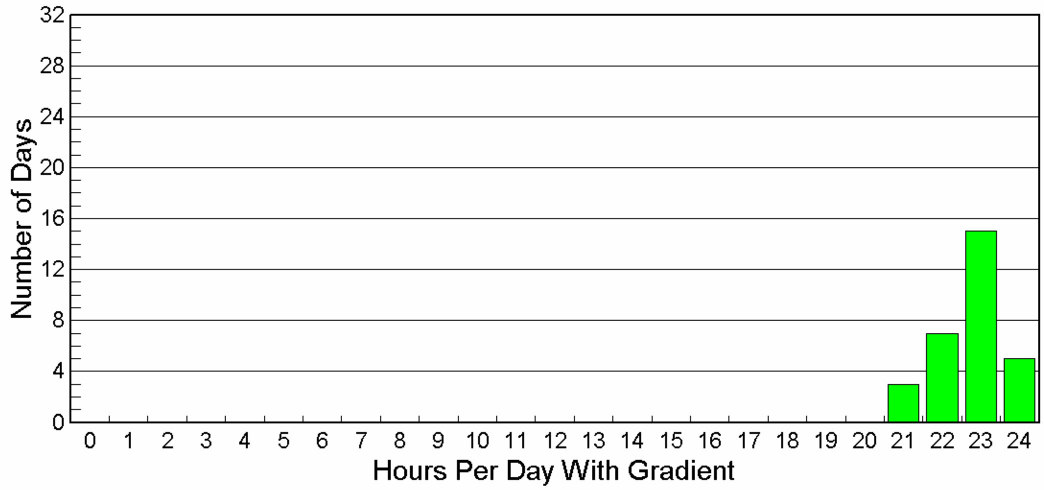
Initial Stewardship Conditions



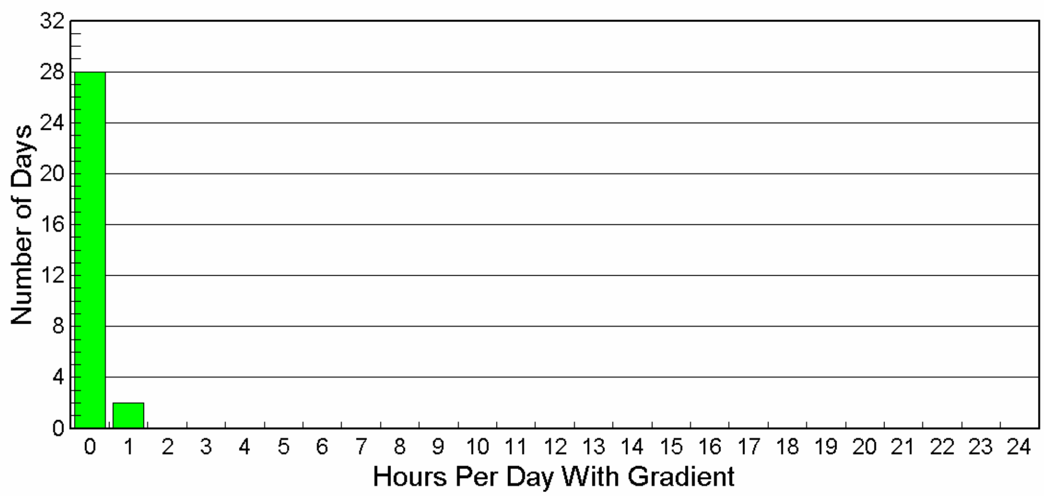
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction. Predicted based on 1994-1995 weather and tidal conditions.

Appendix A. Figure 6. Predicted Presence of a Salinity Gradient in the **Alameda Flood Control Channel** using a **3 ppt Gradient Reversal Threshold**. Comparison of Gradients Predicted for "Existing Conditions" and "Initial Stewardship Conditions" in **March**.

Existing Conditions



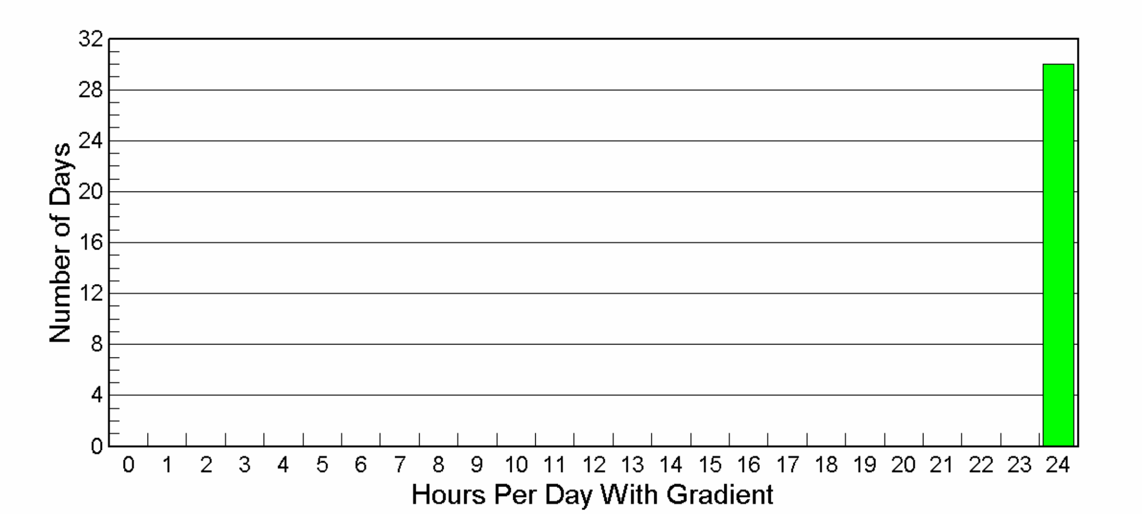
Initial Stewardship Conditions



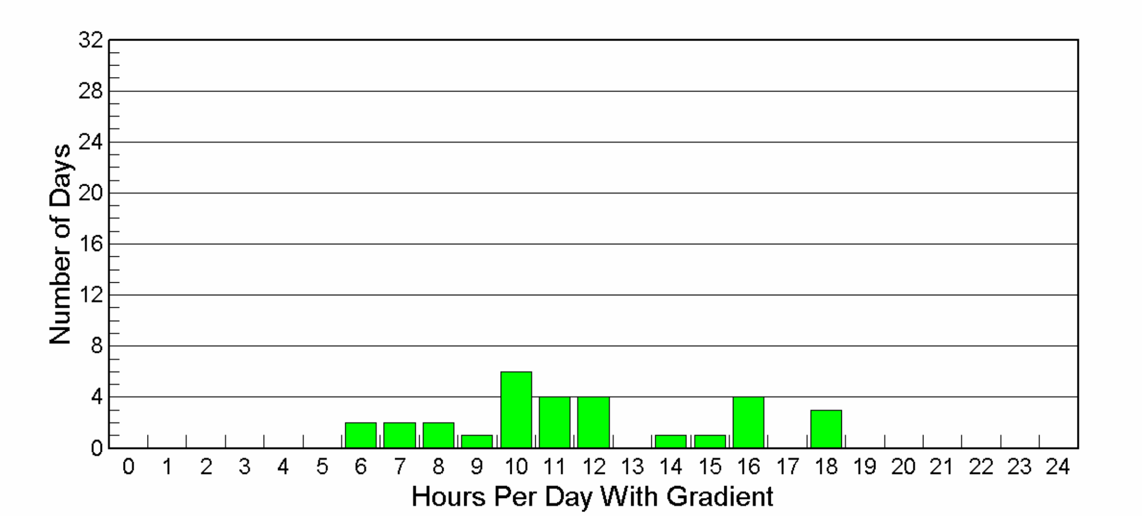
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction. Predicted based on 1994-1995 weather and tidal conditions.

Appendix B. Figure 1. Predicted Presence of a Salinity Gradient in **Alviso Slough** using a **1 ppt Gradient Reversal Threshold**. Comparison of Gradients Predicted for "Existing Conditions" and "Initial Stewardship Conditions" in **September**.

Existing Conditions



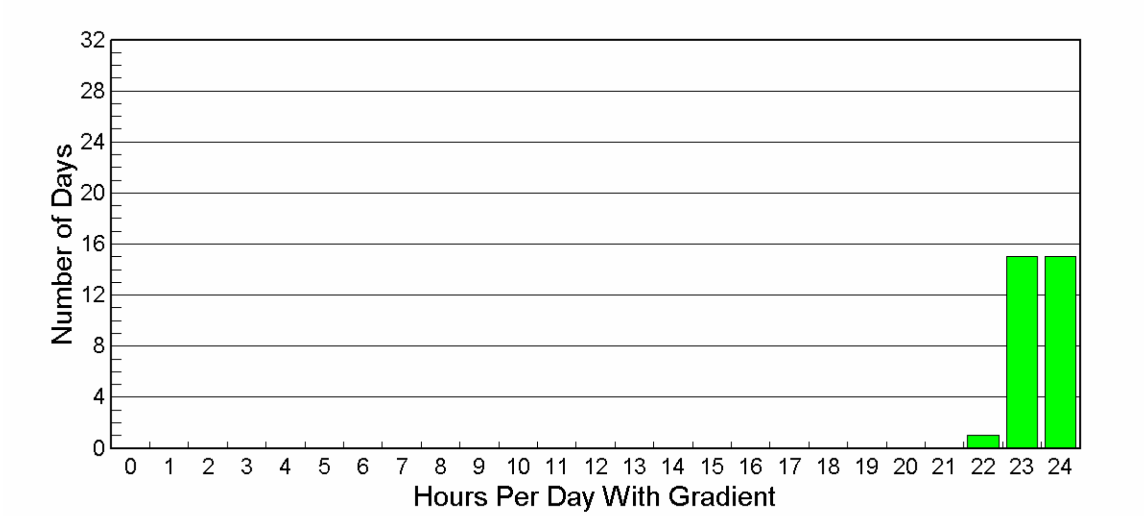
Initial Stewardship Conditions



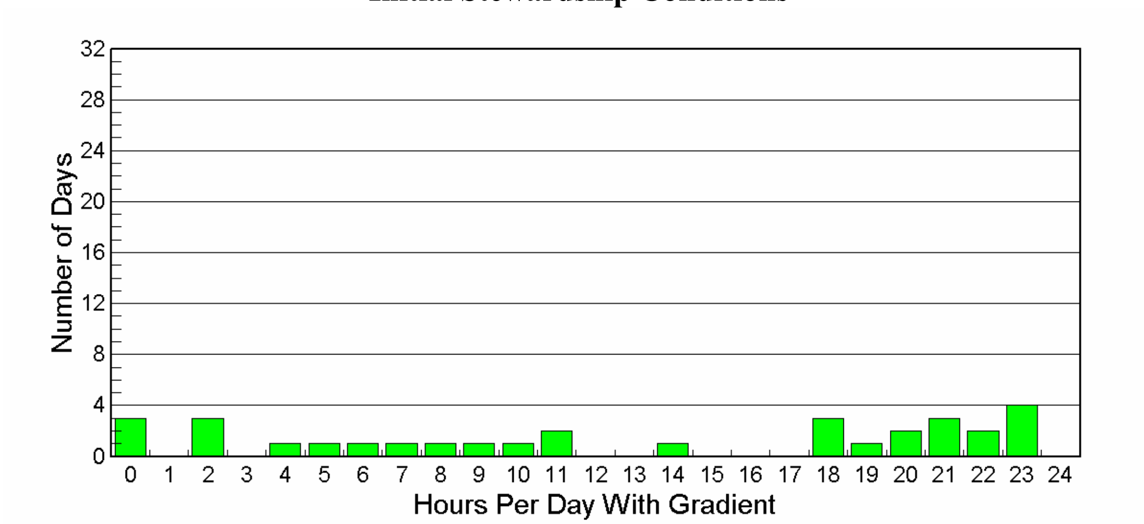
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction. Predicted based on 1994-1995 weather and tidal conditions.

Appendix B. Figure 2. Predicted Presence of a Salinity Gradient in **Alviso Slough** using a **3 ppt Gradient Reversal Threshold**. Comparison of Gradients Predicted for "Existing Conditions" and "Initial Stewardship Conditions" in **September**.

Existing Conditions



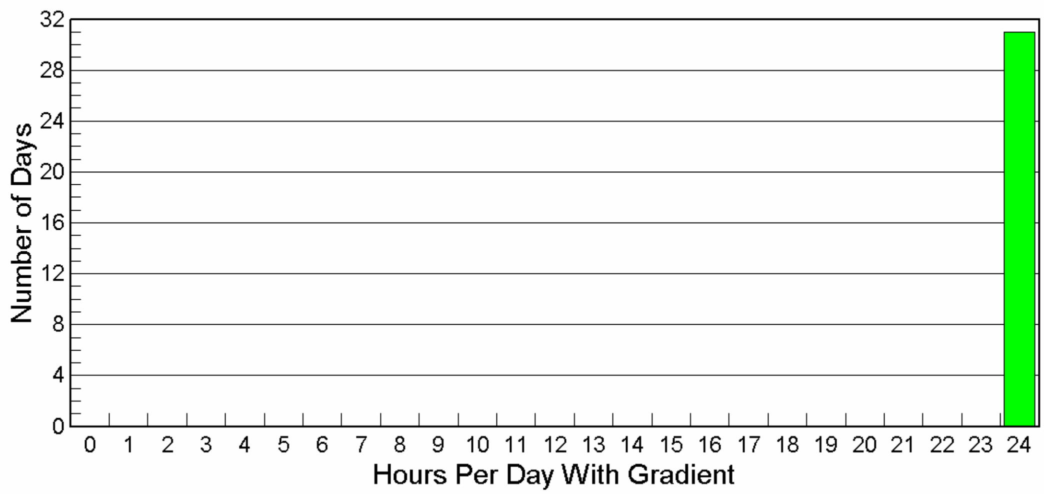
Initial Stewardship Conditions



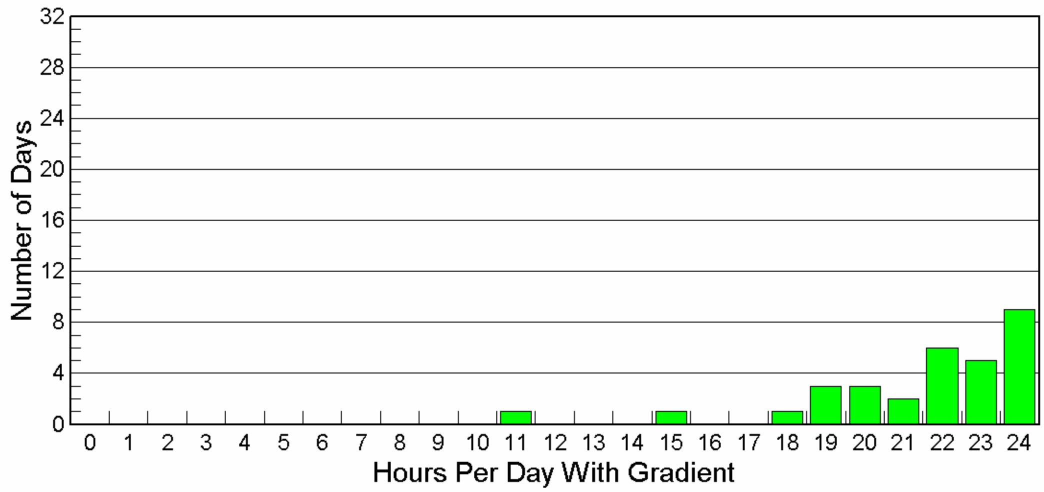
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction. Predicted based on 1994-1995 weather and tidal conditions.

Appendix B. Figure 3. Predicted Presence of a Salinity Gradient in **Alviso Slough** using a **1 ppt Gradient Reversal Threshold**. Comparison of Gradients Predicted for "Existing Conditions" and "Initial Stewardship Conditions" in **October**.

Existing Conditions



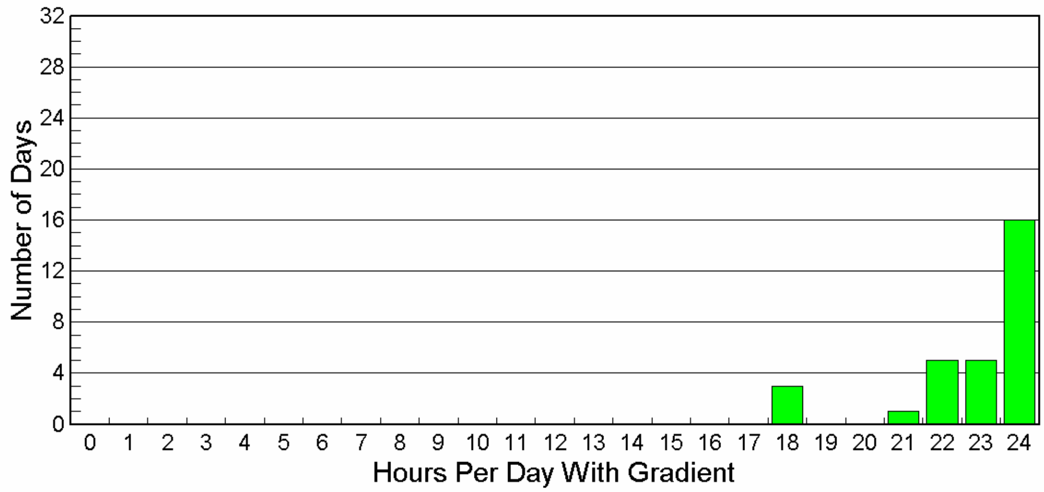
Initial Stewardship Conditions



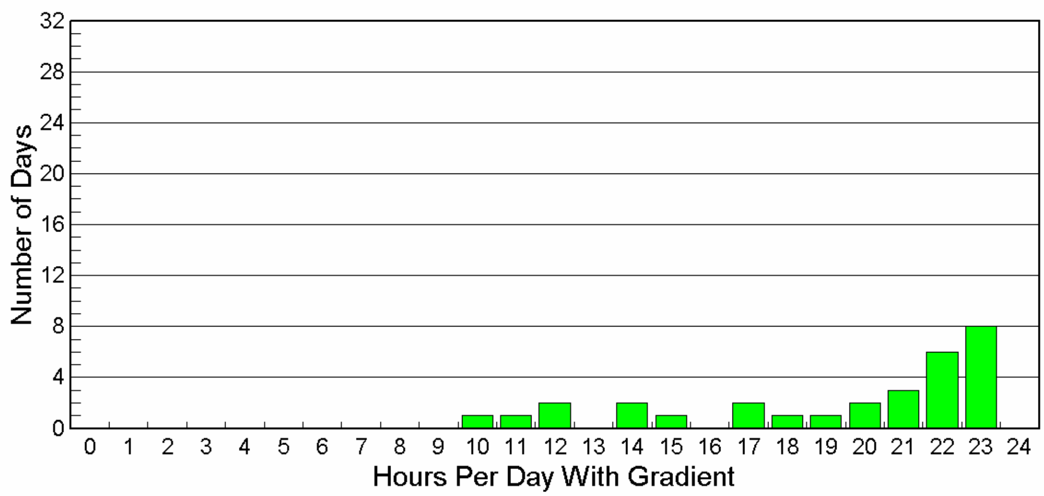
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction. Predicted based on 1994-1995 weather and tidal conditions.

Appendix B. Figure 4. Predicted Presence of a Salinity Gradient in **Alviso Slough** using a **3 ppt Gradient Reversal Threshold**. Comparison of Gradients Predicted for “Existing Conditions” and “Initial Stewardship Conditions” in **October**.

Existing Conditions



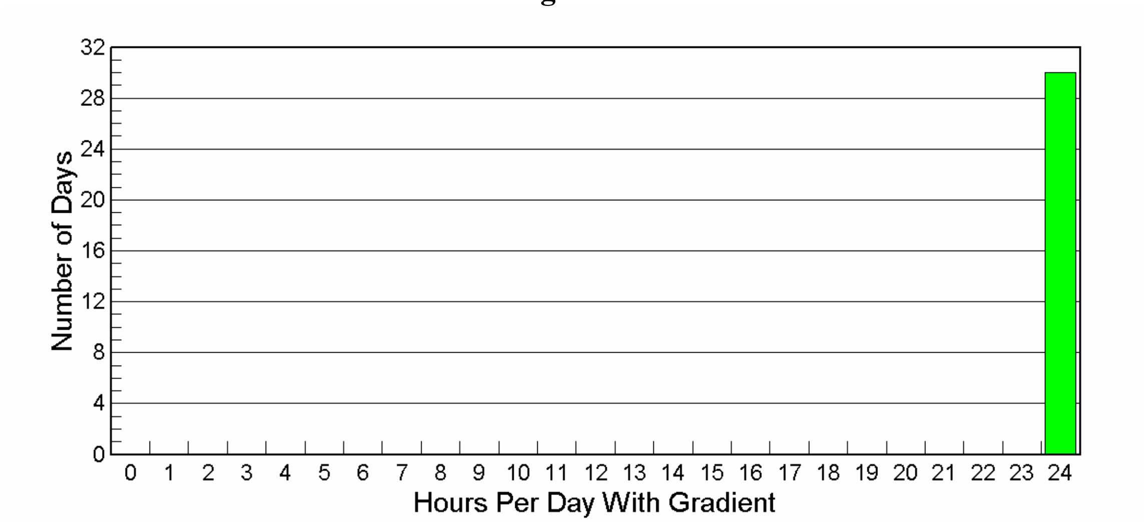
Initial Stewardship Conditions



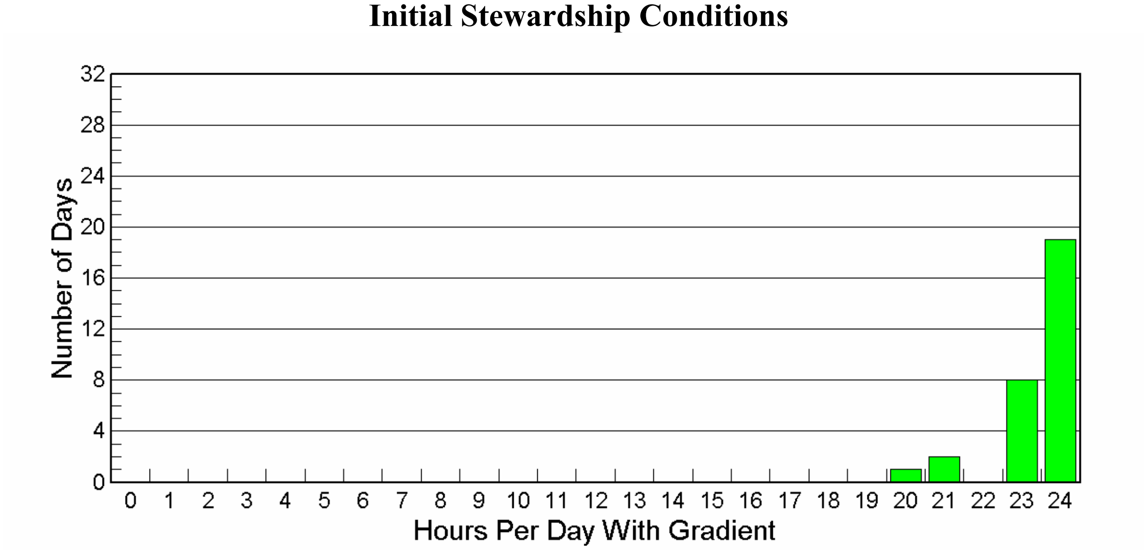
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction. Predicted based on 1994-1995 weather and tidal conditions.

Appendix B. Figure 5. Predicted Presence of a Salinity Gradient in **Alviso Slough** using a **1 ppt Gradient Reversal Threshold**. Comparison of Gradients Predicted for "Existing Conditions" and "Initial Stewardship Conditions" in **November**.

Existing Conditions



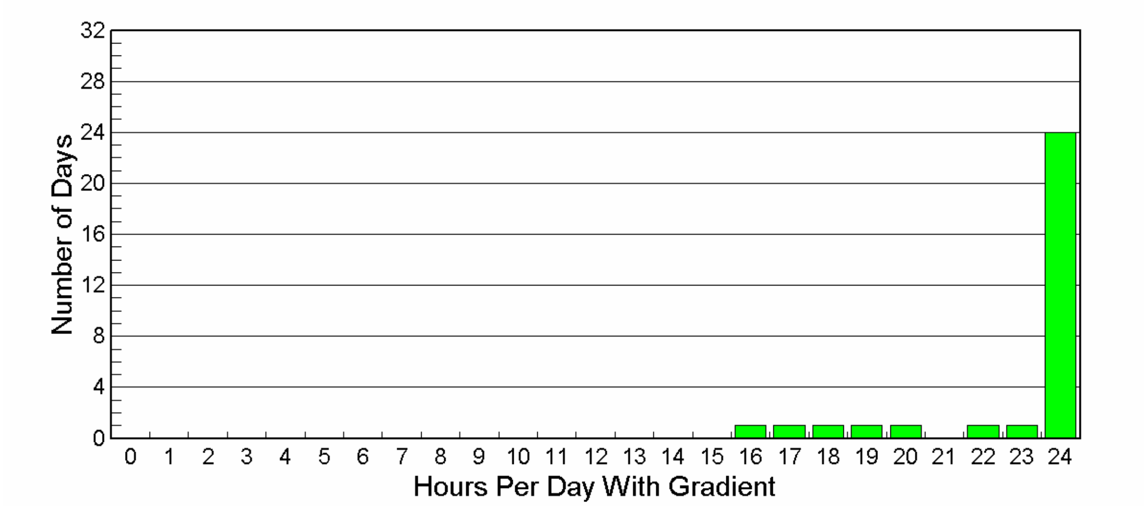
Initial Stewardship Conditions



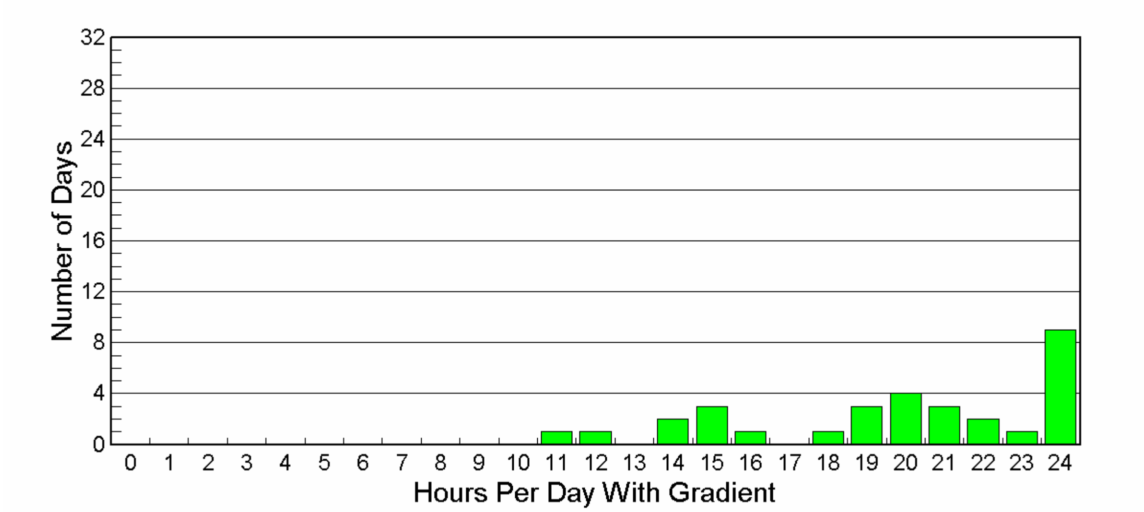
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction. Predicted based on 1994-1995 weather and tidal conditions.

Appendix B. Figure 6. Predicted Presence of a Salinity Gradient in **Alviso Slough** using a **3 ppt Gradient Reversal Threshold**. Comparison of Gradients Predicted for "Existing Conditions" and "Initial Stewardship Conditions" in **November**.

Existing Conditions



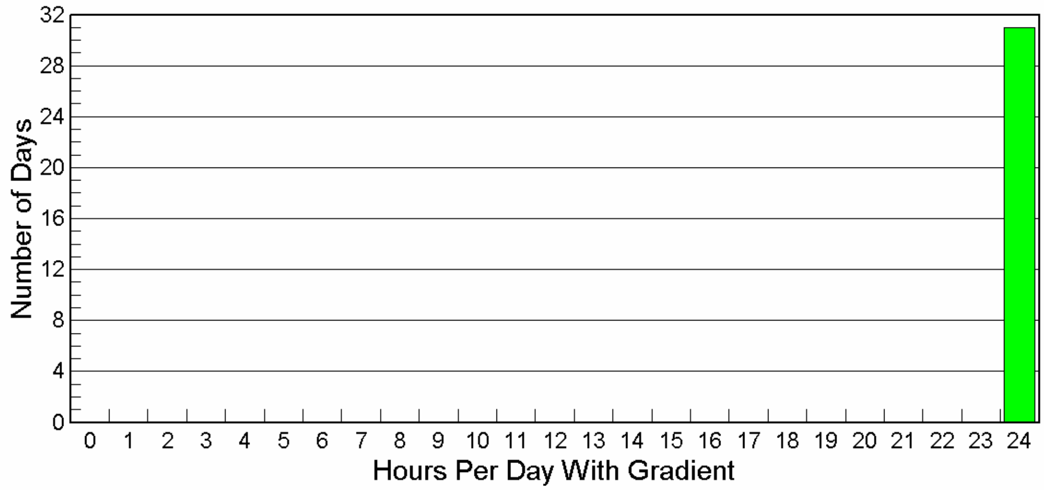
Initial Stewardship Conditions



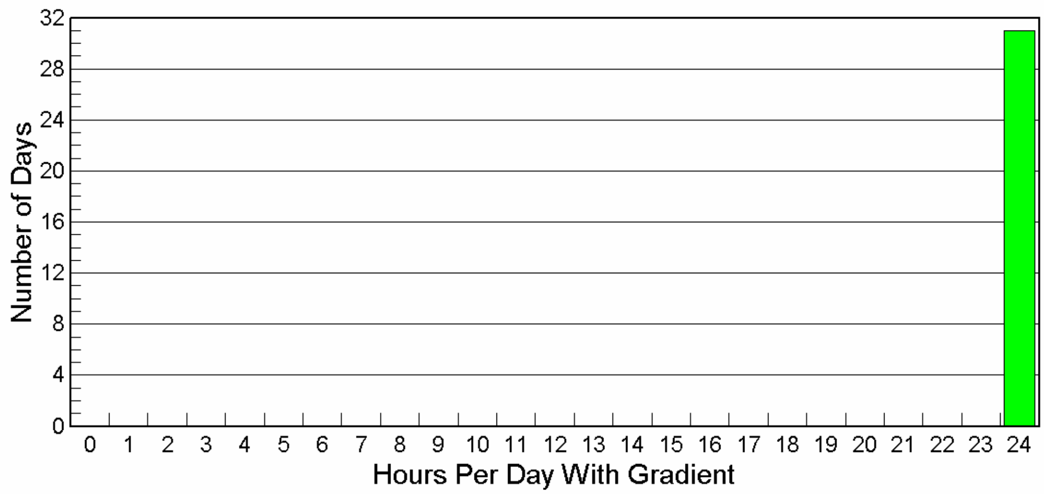
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction. Predicted based on 1994-1995 weather and tidal conditions.

Appendix C. Figure 1. Predicted Presence of a Salinity Gradient in **Alviso Slough** using a **1 ppt Gradient Reversal Threshold**. Comparison of Gradients Predicted for "Existing Conditions" and "Initial Stewardship Conditions" in **January**.

Existing Conditions



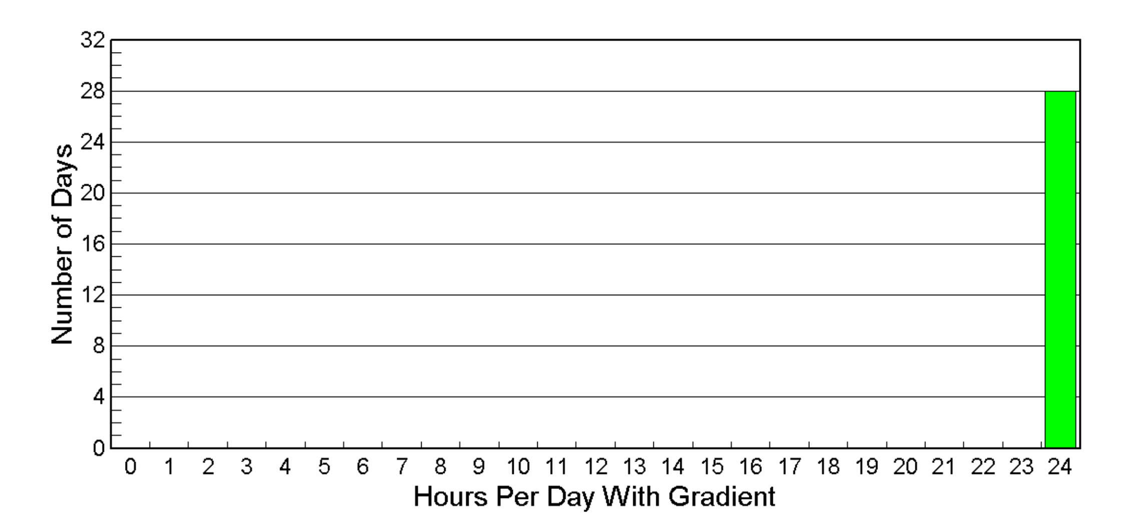
Initial Stewardship Conditions



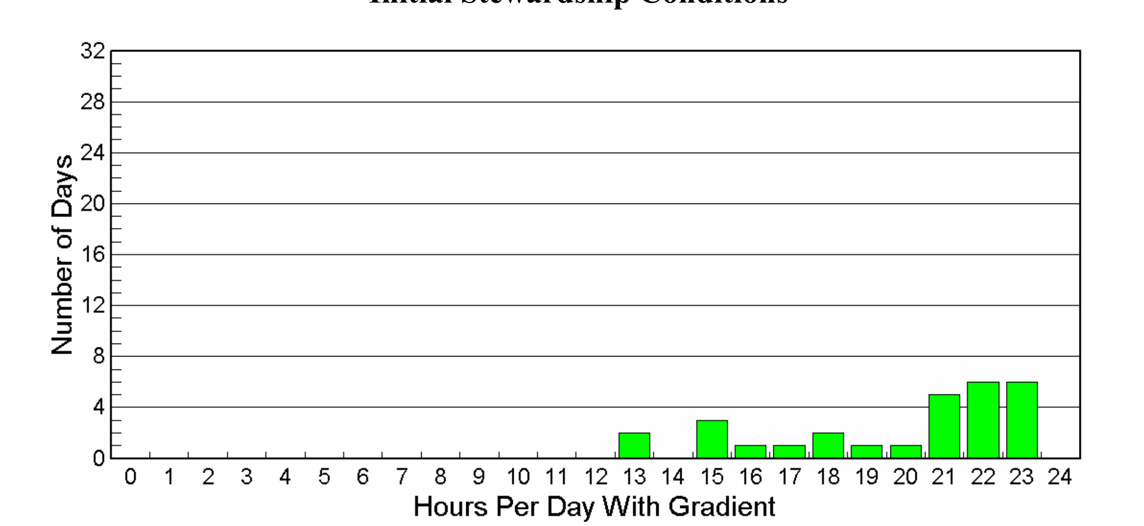
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction. Predicted based on 1994-1995 weather and tidal conditions.

Appendix C. Figure 2. Predicted Presence of a Salinity Gradient in **Alviso Slough** using a **3 ppt Gradient Reversal Threshold**. Comparison of Gradients Predicted for “Existing Conditions” and “Initial Stewardship Conditions” in **January**.

Existing Conditions



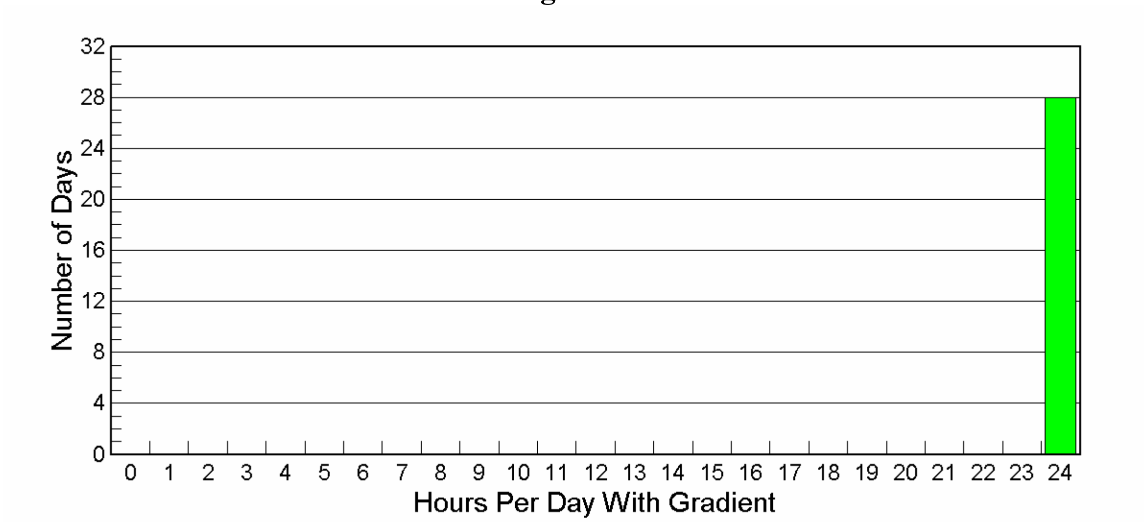
Initial Stewardship Conditions



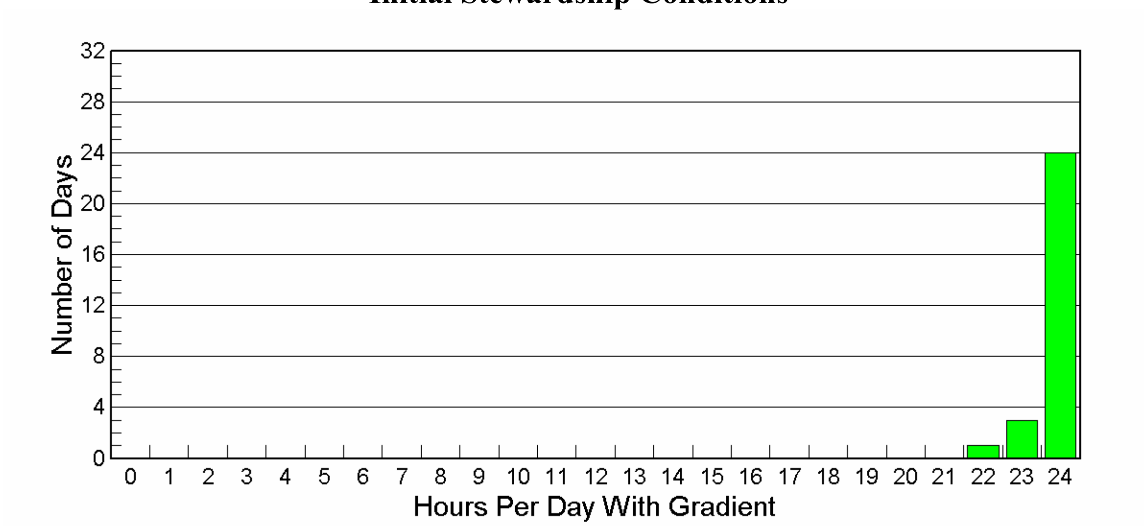
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction. Predicted based on 1994-1995 weather and tidal conditions.

Appendix C. Figure 3. Predicted Presence of a Salinity Gradient in **Alviso Slough** using a **1 ppt Gradient Reversal Threshold**. Comparison of Gradients Predicted for "Existing Conditions" and "Initial Stewardship Conditions" in **February**.

Existing Conditions



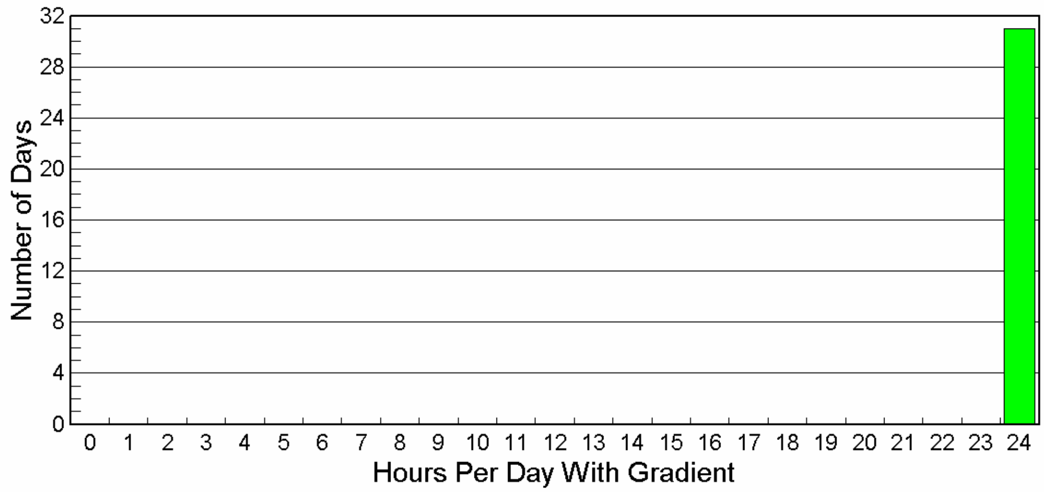
Initial Stewardship Conditions



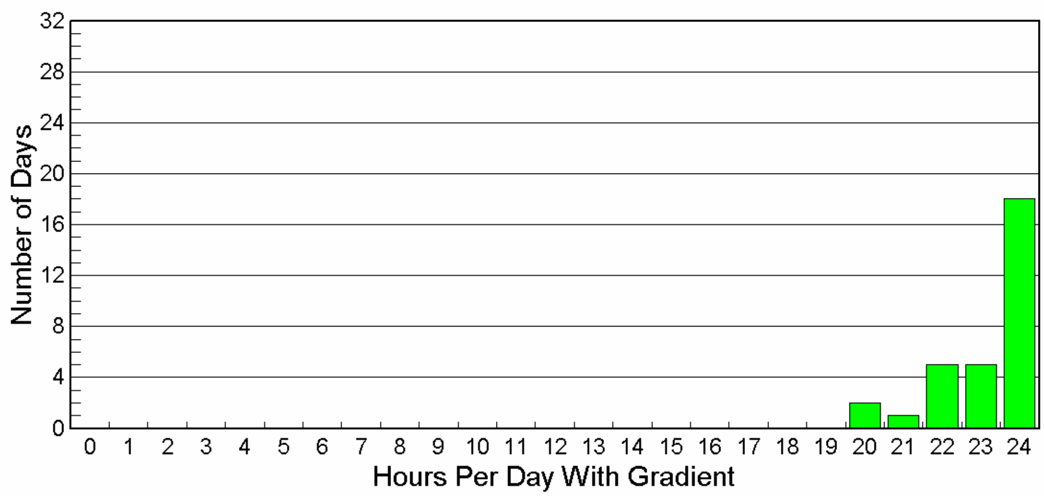
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction. Predicted based on 1994-1995 weather and tidal conditions.

Appendix C. Figure 4. Predicted Presence of a Salinity Gradient in **Alviso Slough** using a **3 ppt Gradient Reversal Threshold**. Comparison of Gradients Predicted for "Existing Conditions" and "Initial Stewardship Conditions" in **February**.

Existing Conditions



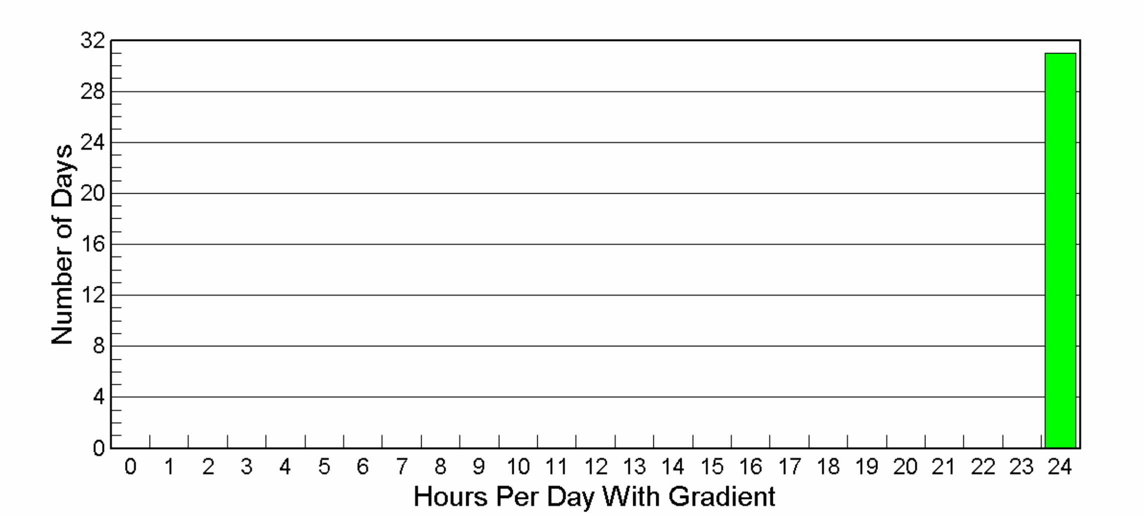
Initial Stewardship Conditions



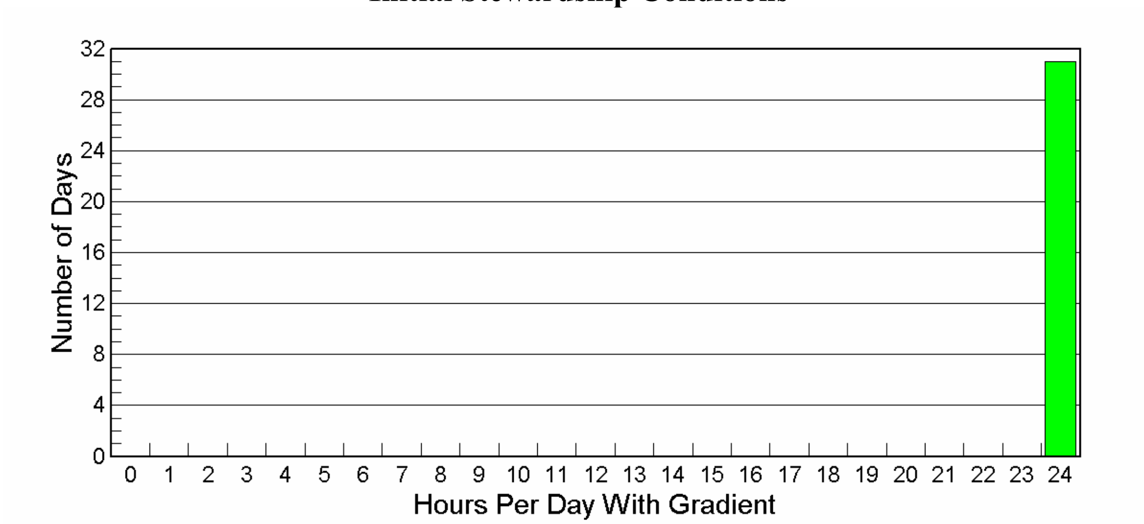
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction. Predicted based on 1994-1995 weather and tidal conditions.

Appendix C. Figure 5. Predicted Presence of a Salinity Gradient in **Alviso Slough** using a **1 ppt Gradient Reversal Threshold**. Comparison of Gradients Predicted for "Existing Conditions" and "Initial Stewardship Conditions" in **March**.

Existing Conditions



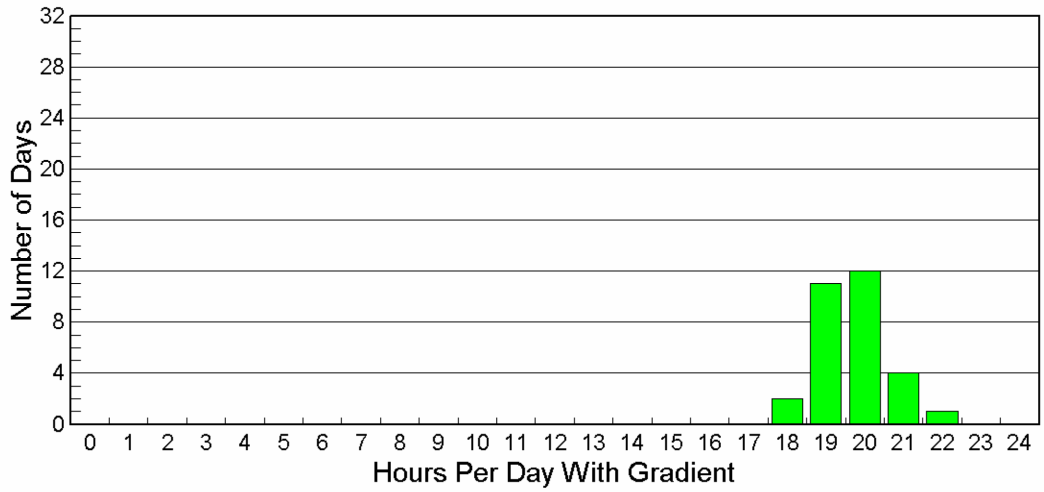
Initial Stewardship Conditions



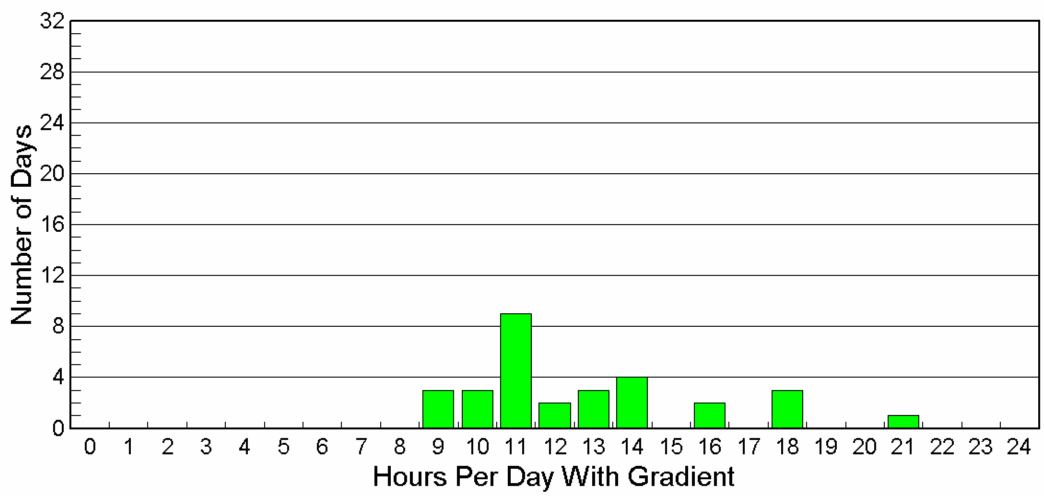
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction. Predicted based on 1994-1995 weather and tidal conditions.

Appendix C. Figure 6. Predicted Presence of a Salinity Gradient in **Alviso Slough** using a **3 ppt Gradient Reversal Threshold**. Comparison of Gradients Predicted for "Existing Conditions" and "Initial Stewardship Conditions" in **March**.

Existing Conditions



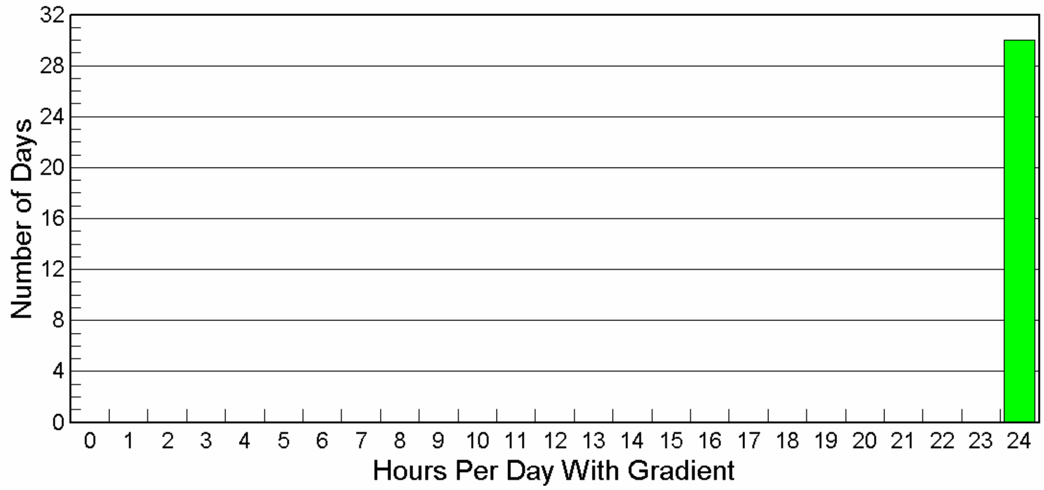
Initial Stewardship Conditions



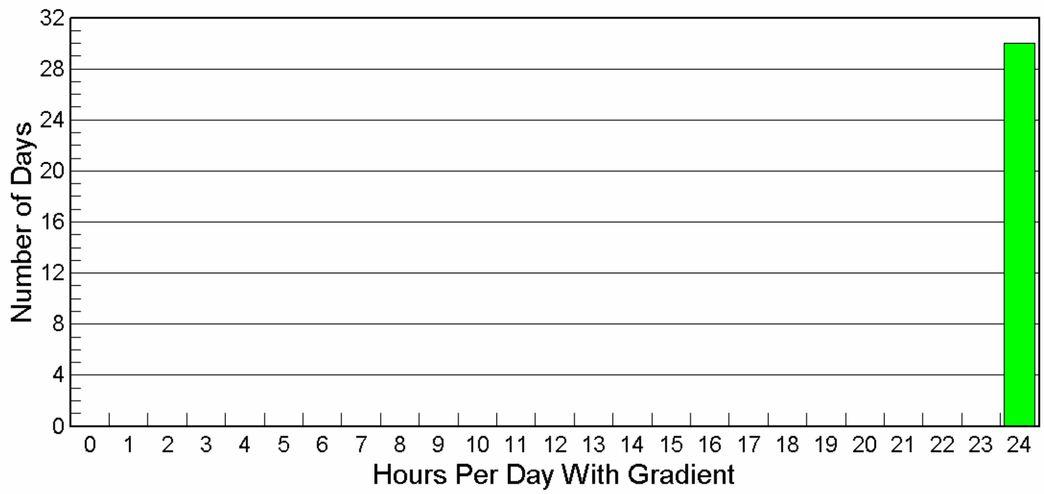
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction. Predicted based on 1994-1995 weather and tidal conditions.

Appendix D. Figure 1. Predicted Presence of a Salinity Gradient in **Coyote Creek** using a **1 ppt Gradient Reversal Threshold**. Comparison of Gradients Predicted for “Existing Conditions” and “Initial Stewardship Conditions” in **September**.

Existing Conditions



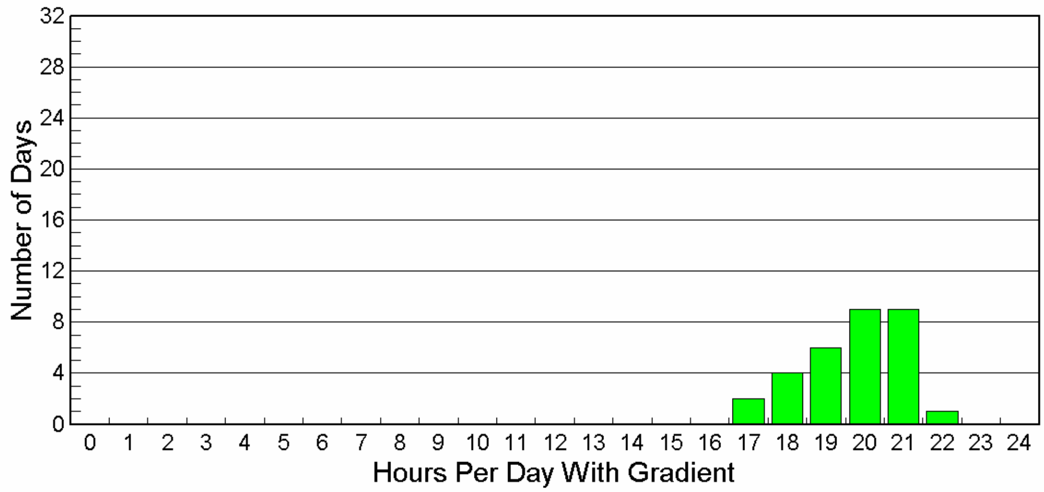
Initial Stewardship Conditions



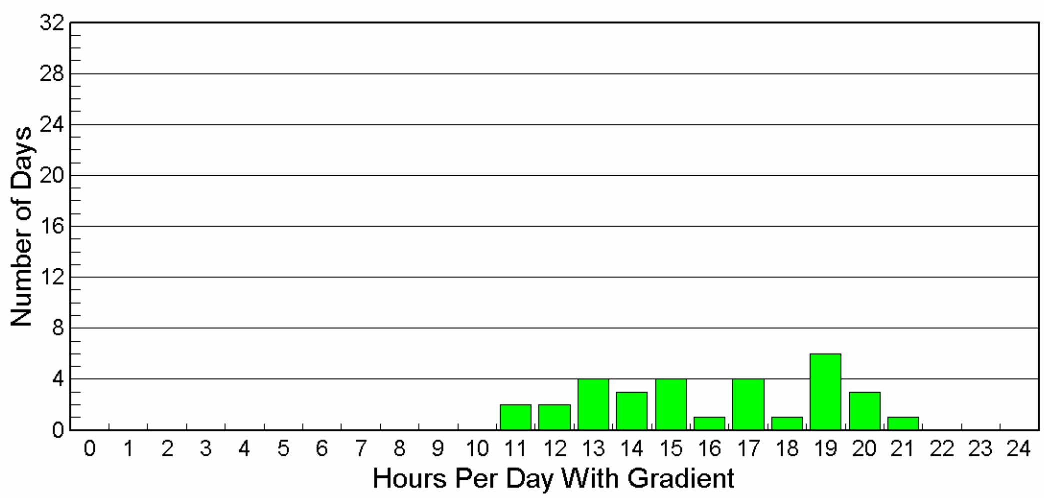
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction. Predicted based on 1994-1995 weather and tidal conditions.

Appendix D. Figure 2. Predicted Presence of a Salinity Gradient in **Coyote Creek** using a **3 ppt Gradient Reversal Threshold**. Comparison of Gradients Predicted for “Existing Conditions” and “Initial Stewardship Conditions” in **September**.

Existing Conditions



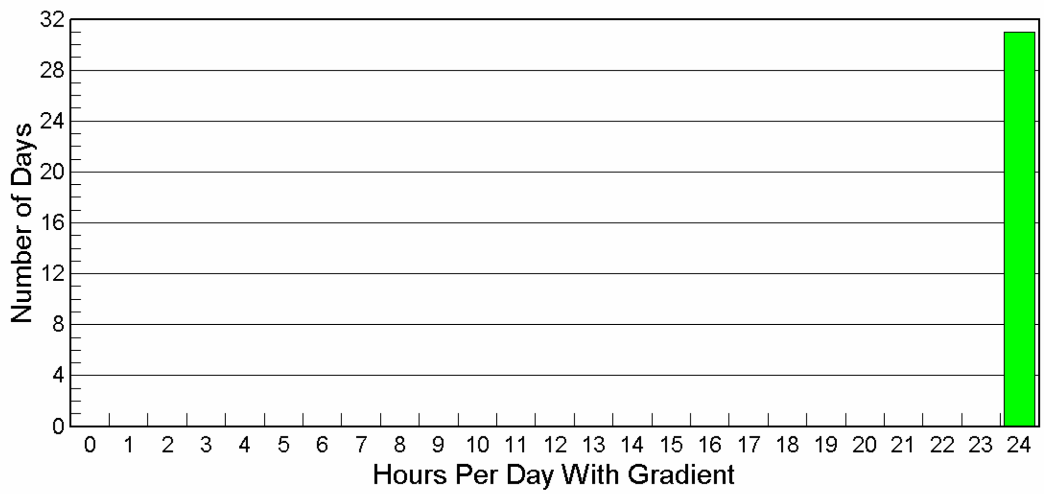
Initial Stewardship Conditions



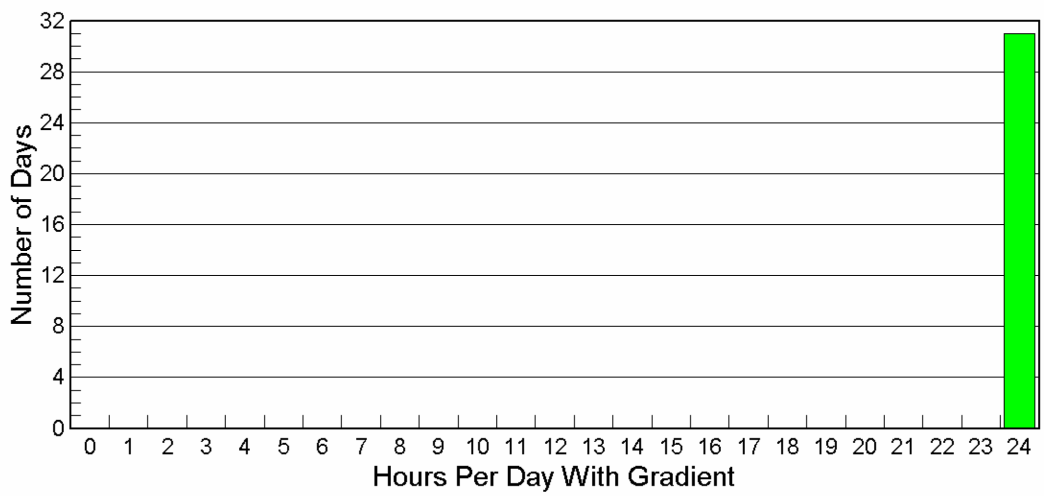
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction. Predicted based on 1994-1995 weather and tidal conditions.

Appendix D. Figure 3. Predicted Presence of a Salinity Gradient in **Coyote Creek** using a **1 ppt Gradient Reversal Threshold**. Comparison of Gradients Predicted for “Existing Conditions” and “Initial Stewardship Conditions” in **October**.

Existing Conditions



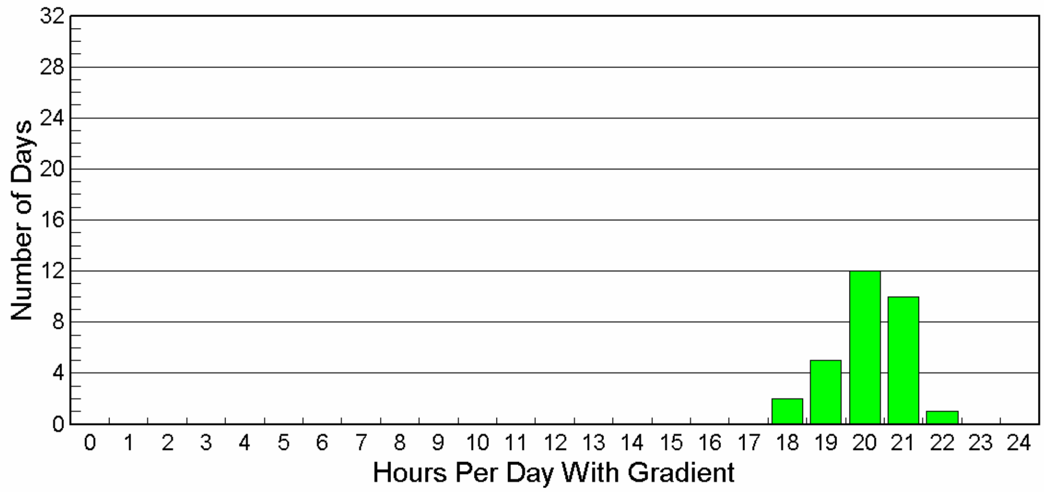
Initial Stewardship Conditions



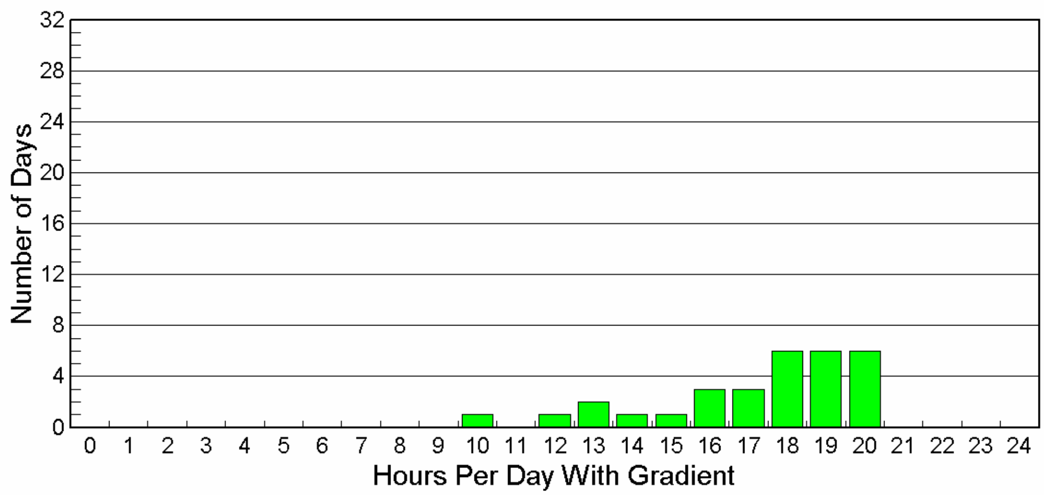
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction. Predicted based on 1994-1995 weather and tidal conditions.

Appendix D. Figure 4. Predicted Presence of a Salinity Gradient in **Coyote Creek** using a **3 ppt Gradient Reversal Threshold**. Comparison of Gradients Predicted for "Existing Conditions" and "Initial Stewardship Conditions" in **October**.

Existing Conditions



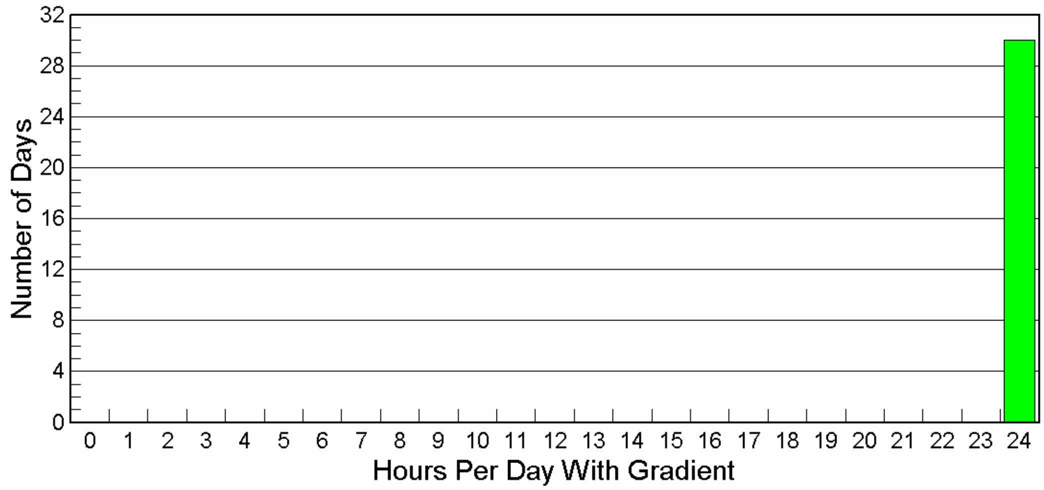
Initial Stewardship Conditions



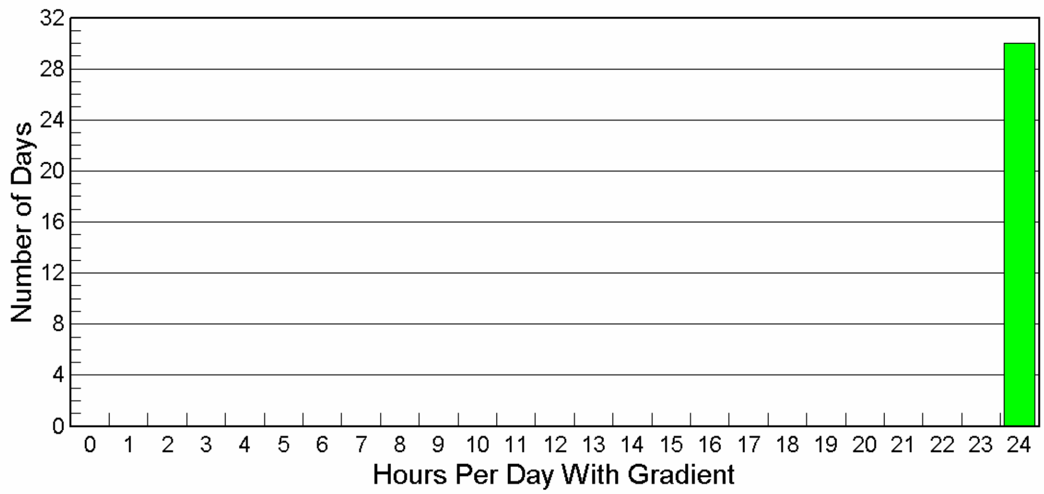
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction. Predicted based on 1994-1995 weather and tidal conditions.

Appendix D. Figure 5. Predicted Presence of a Salinity Gradient in **Coyote Creek** using a **1 ppt Gradient Reversal Threshold**. Comparison of Gradients Predicted for "Existing Conditions" and "Initial Stewardship Conditions" in **November**.

Existing Conditions



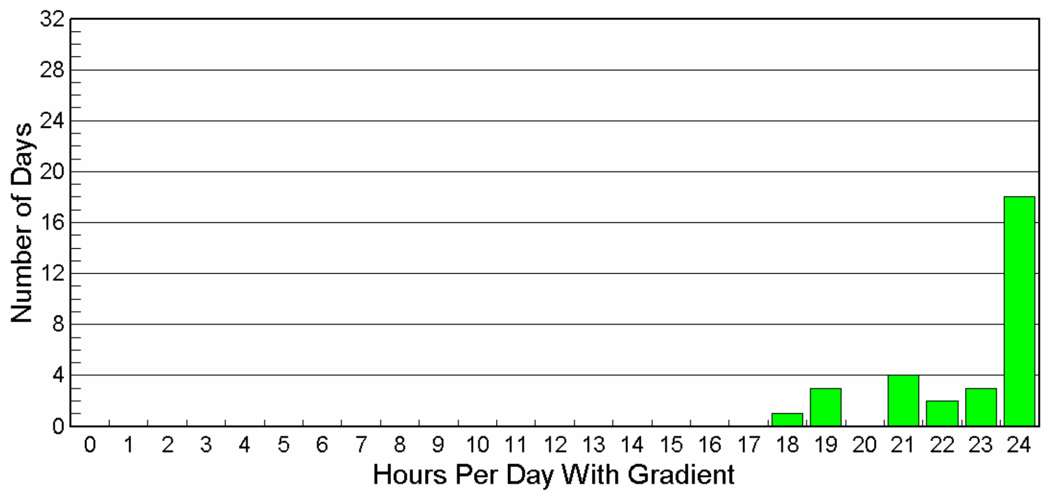
Initial Stewardship Conditions



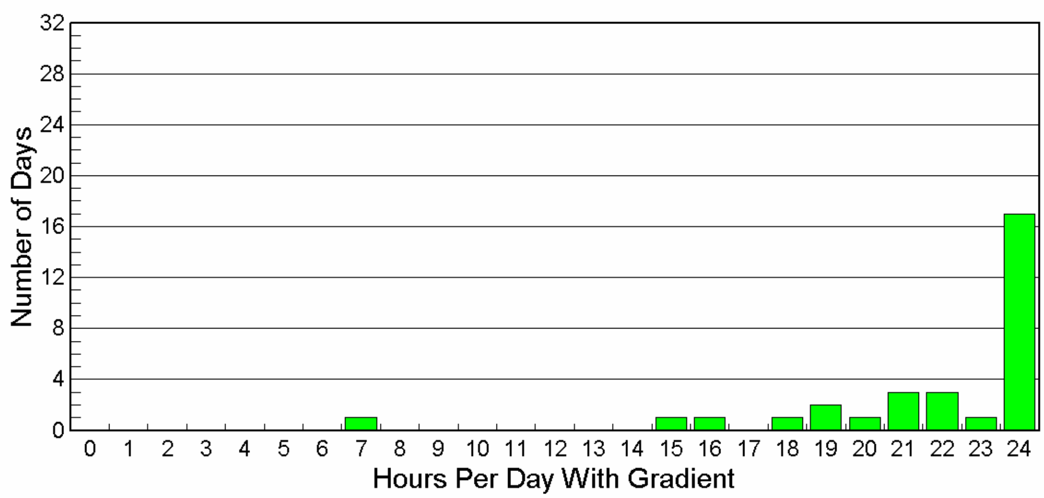
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction. Predicted based on 1994-1995 weather and tidal conditions.

Appendix D. Figure 6. Predicted Presence of a Salinity Gradient in **Coyote Creek** using a **3 ppt Gradient Reversal Threshold**. Comparison of Gradients Predicted for “Existing Conditions” and “Initial Stewardship Conditions” in **November**.

Existing Conditions



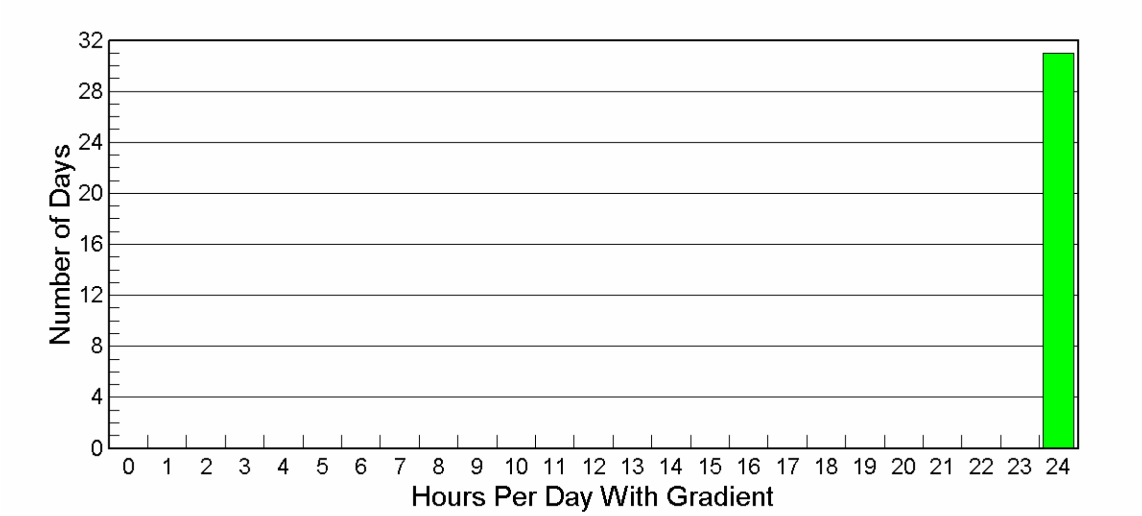
Initial Stewardship Conditions



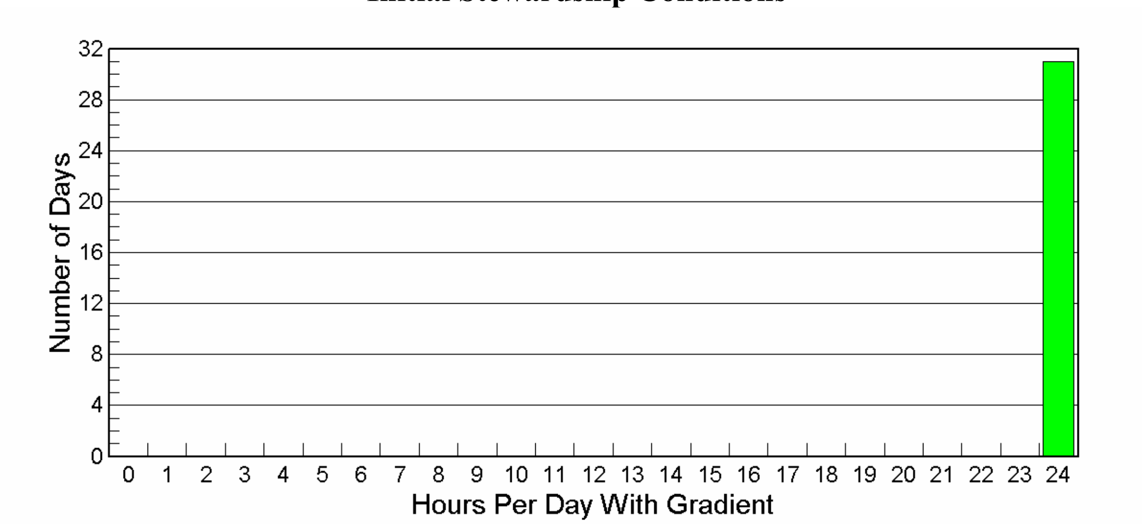
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction. Predicted based on 1994-1995 weather and tidal conditions.

Appendix E. Figure 1. Predicted Presence of a Salinity Gradient in **Coyote Creek** using a **1 ppt Gradient Reversal Threshold**. Comparison of Gradients Predicted for "Existing Conditions" and "Initial Stewardship Conditions" in **January**.

Existing Conditions



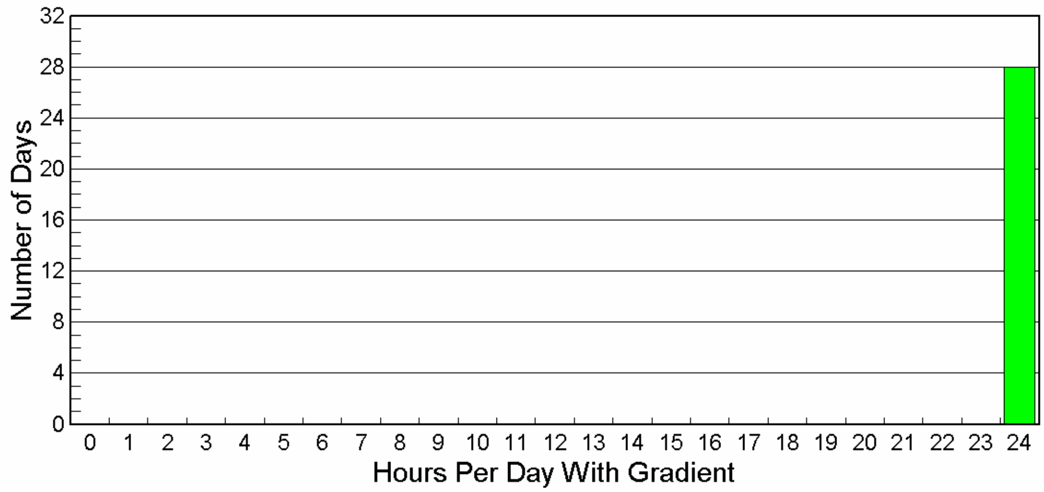
Initial Stewardship Conditions



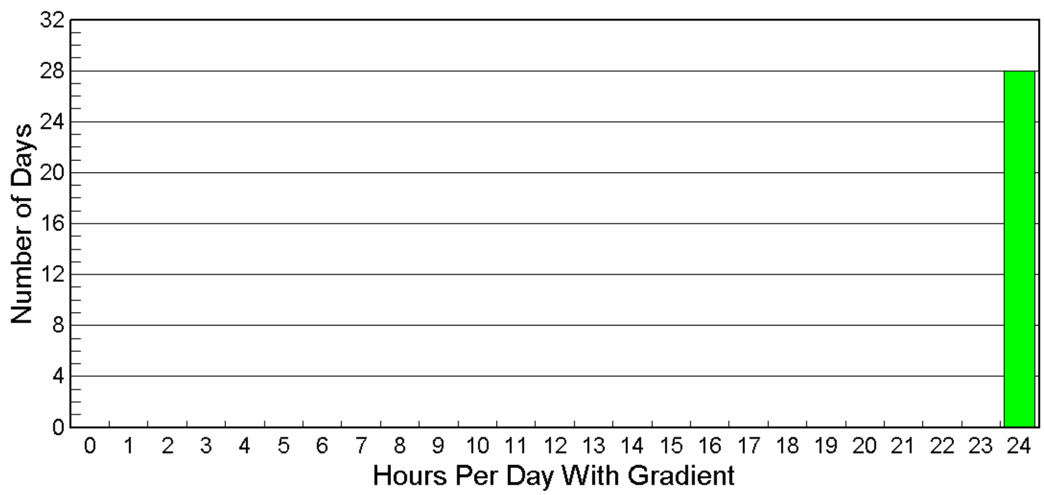
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction. Predicted based on 1994-1995 weather and tidal conditions.

Appendix E. Figure 2. Predicted Presence of a Salinity Gradient in **Coyote Creek** using a **3 ppt Gradient Reversal Threshold**. Comparison of Gradients Predicted for "Existing Conditions" and "Initial Stewardship Conditions" in **January**.

Existing Conditions



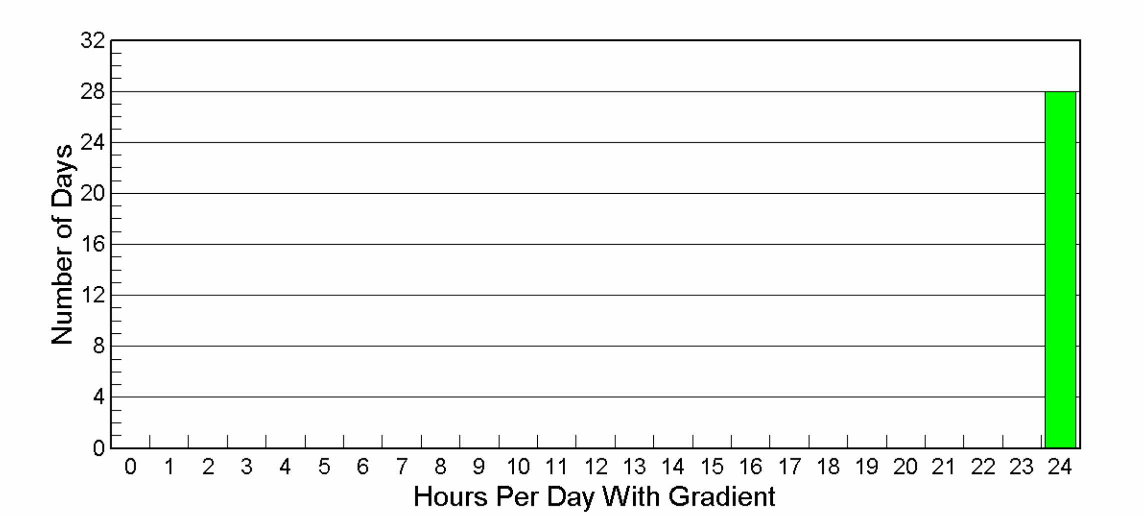
Initial Stewardship Conditions



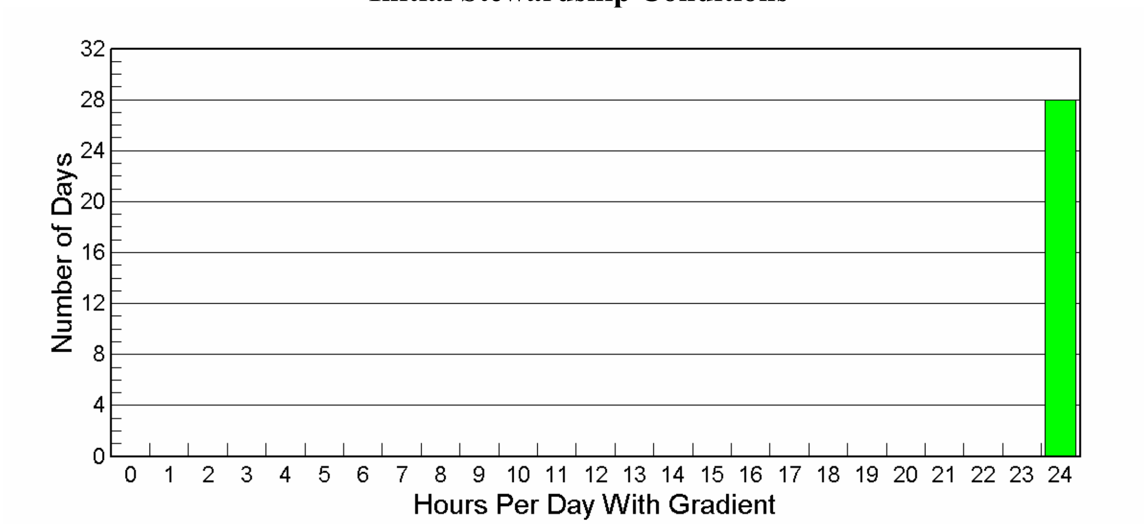
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction. Predicted based on 1994-1995 weather and tidal conditions.

Appendix E. Figure 3. Predicted Presence of a Salinity Gradient in **Coyote Creek** using a **1 ppt Gradient Reversal Threshold**. Comparison of Gradients Predicted for "Existing Conditions" and "Initial Stewardship Conditions" in **February**.

Existing Conditions



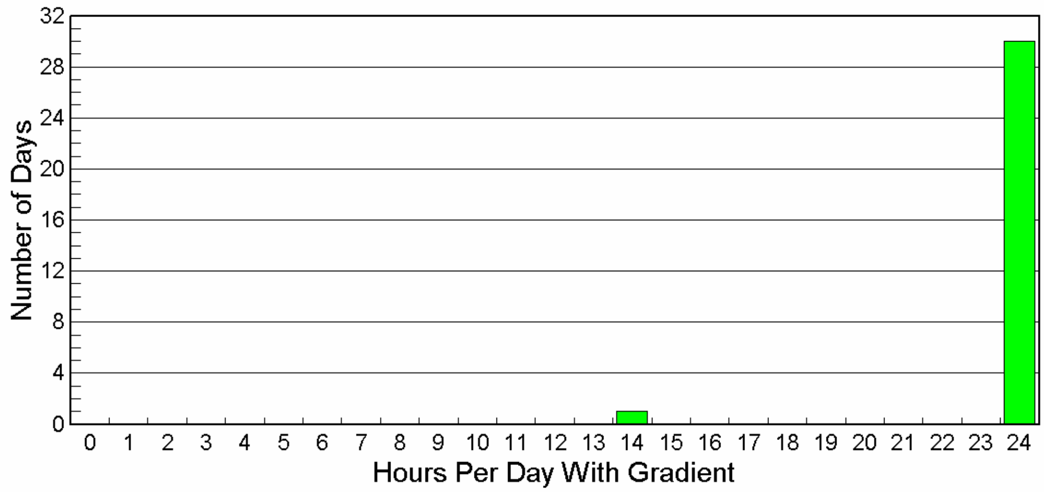
Initial Stewardship Conditions



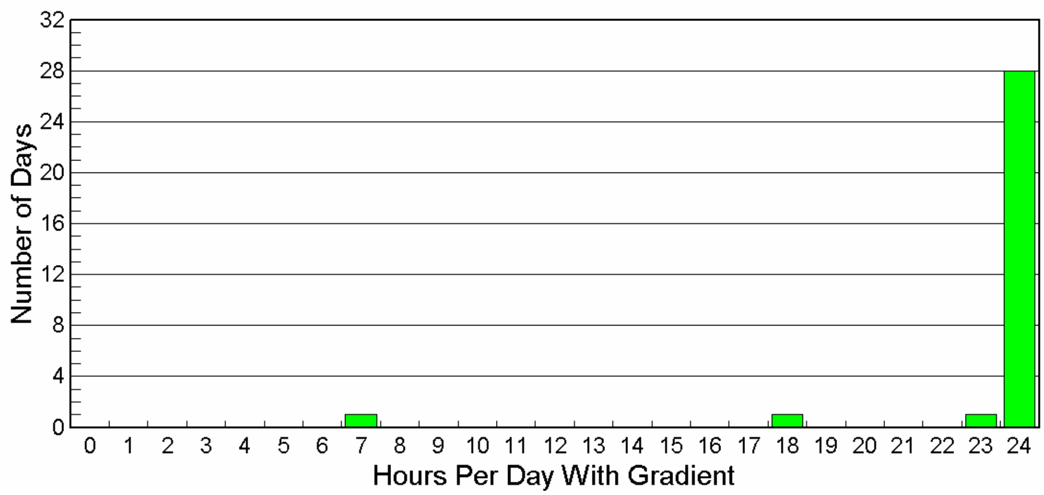
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction. Predicted based on 1994-1995 weather and tidal conditions.

Appendix E. Figure 4. Predicted Presence of a Salinity Gradient in **Coyote Creek** using a **3 ppt Gradient Reversal Threshold**. Comparison of Gradients Predicted for "Existing Conditions" and "Initial Stewardship Conditions" in **February**.

Existing Conditions



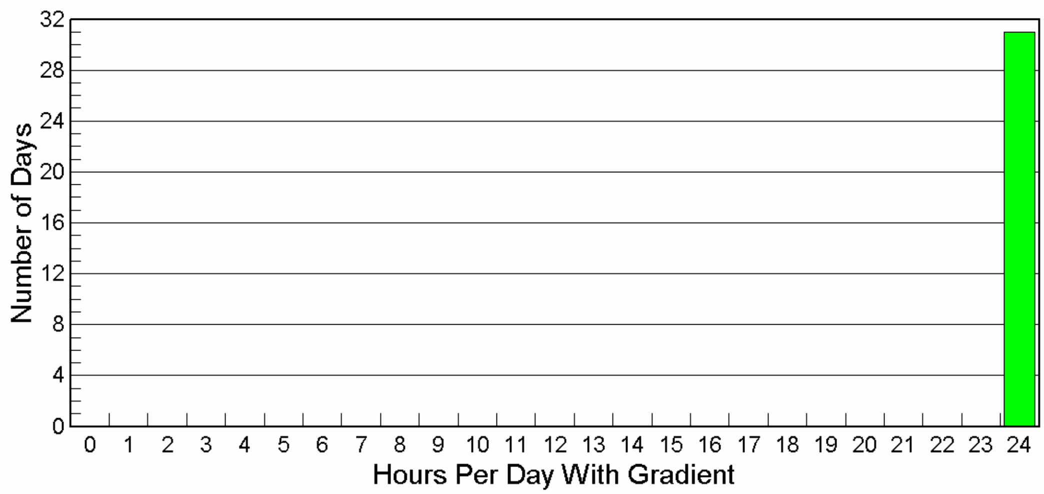
Initial Stewardship Conditions



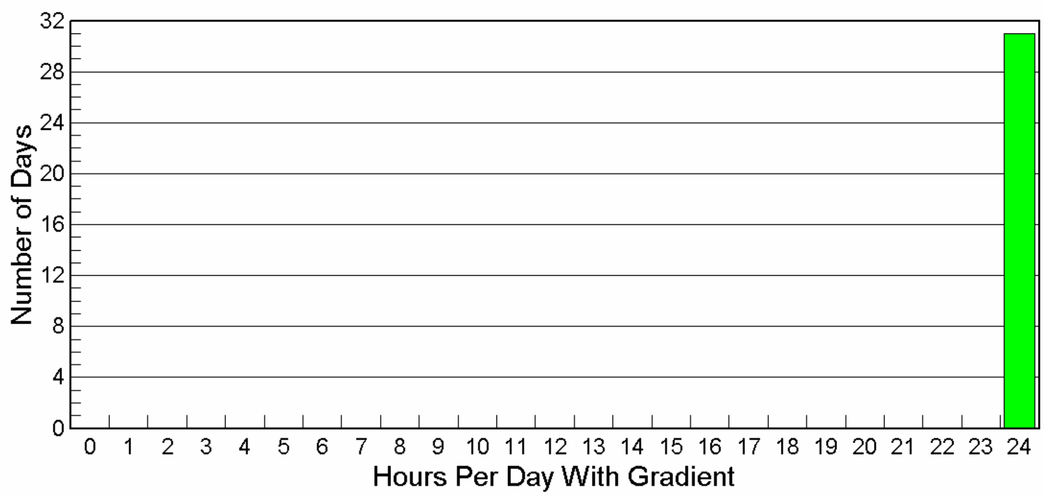
Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction. Predicted based on 1994-1995 weather and tidal conditions.

Appendix E. Figure 5. Predicted Presence of a Salinity Gradient in **Coyote Creek** using a **1 ppt Gradient Reversal Threshold**. Comparison of Gradients Predicted for "Existing Conditions" and "Initial Stewardship Conditions" in **March**.

Existing Conditions



Initial Stewardship Conditions



Note: Presence of salinity gradient computed based on predicted depth averaged salinity at 250 meter intervals in the longitudinal direction. Predicted based on 1994-1995 weather and tidal conditions.

Appendix E. Figure 6. Predicted Presence of a Salinity Gradient in **Coyote Creek** using a **3 ppt Gradient Reversal Threshold**. Comparison of Gradients Predicted for “Existing Conditions” and “Initial Stewardship Conditions” in **March**.

Report 6/9/03

EVALUATION OF THE POTENTIAL FOR SALINITY IMPACTS ON BAY SHRIMP ASSOCIATED WITH CIRCULATION OF SALINE POND WATER DURING THE INITIAL STEWARDSHIP PERIOD

Prepared by
Stephen R. Hansen, Ph.D.
S.R. Hansen & Associates

1. OVERVIEW

Based on discussions with staff from California Department of Fish and Game, National Marine Fisheries Service, and the San Francisco Regional Water Quality Control Board, the bay shrimp (*Crangon franciscorum*) was identified as being of particular interest in those locations in and around South San Francisco Bay where saline pond water would be discharged during the Initial Stewardship Period. The special concern for the bay shrimp arises from the fact that there is a commercial fishery for this species in the South Bay and the juveniles of this species live in the sloughs into which saline pond water would be circulated. Reportedly, these juveniles have specific salinity requirements which are currently being met in South Bay sloughs and creeks. As described in this document, an evaluation was performed to determine if the altered salinity profiles in the sloughs during the Initial Stewardship Period would adversely impact the bay shrimp. The results of this evaluation indicate that salinity changes associated with the circulation are predicted to be relatively small and localized and are, therefore, not expected to adversely impact the long-term quality or quantity of habitat available to the bay shrimp. Any local decreases in habitat quality are predicted to be of short duration and limited to the first few months following the initial release of pond water. The evaluations upon which these conclusions are based are described in the following sections of this document.

2. NATURE OF THE FISHERY

Currently, the bay shrimp is caught commercially in the South Bay, with between 2 and 4 boats fishing in this area each year and annually landing approximately 75,000 pounds at an estimated annual value of between $154,000 and $312,000 (personal communication: S. Ashcraft, CDF&G, Belmont, CA). Most commercial fishing for the bay shrimp occurs in South Bay proper between the Dumbarton Bridge and Calaveras Point, at the mouth of Coyote Creek. There appears to be some limited fishing activity for this species occurring in the downstream portion of Coyote Creek, extending approximately 1.5 miles upstream from Calaveras Point.

3. DISTRIBUTION AND ABUNDANCE OF BAY SHRIMP

The bay shrimp is a native species to San Francisco Bay, with distributions in both the northern and southern reaches of the bay. This species is present in South San Francisco Bay and its adjoining tributaries and sloughs throughout the entire year, with densities and age structure of the population exhibiting considerable temporal variability. The life stages of bay shrimp which are found in the sloughs varies over the course of a year, being determined by the life history strategy of the species (S. Hatfield, 1985).

Based on CDF&G fishing log data (provided by S. Ashcraft, CDF&G), the bay shrimp abundance in the main channel of the South Bay (which is also the prime fishing area) varies over the course of the year, with highest abundance in late summer (September and October) and lowest abundance in the early spring (March and April). (see Figure 1).

The catch record agrees with the reported life history characteristics of this species. The bay shrimp reproduces from December to June with the greatest activity in late winter, early spring. When in reproductive condition, a large cohort of the adult bay shrimp migrate out of the South Bay to nearshore ocean waters just outside the Golden Gate. This migration coincides with the low catch numbers reported for March and April in the South Bay as well as elsewhere in the estuary.

According to Hatfield (1985), after spawning, the eggs hatch in 8-12 weeks and the planktonic larvae are carried by the tide into San Francisco Bay and by the currents to Suisun Bay in the north and South Bay in the south. The relative proportion of young larvae that are transported to the north and the south is dependent upon the outflow from the estuary. In dry years, a larger proportion of the population of young larvae are transported southward, while during wet years, northern transport predominates. Once in South Bay, the juveniles prefer shallow, less saline waters and migrate up fresher-water tributaries including Guadalupe Slough, Alviso Slough, and Coyote Creek. The southern migration coincides with the higher South Bay catch data reported for summer and early fall. Due to their ubiquitous presence throughout South Bay, bay shrimp can be assumed to be also present in Old Alameda Creek and the Alameda Flood Control Channel.

According to two studies that evaluated the distribution and abundance of bay shrimp in the South Bay (Baxter et al 1999, Kinnetic Labs 1987), the young-of-the-year bay shrimp arrive in the South Bay and its tributaries primarily in May and are between 11 and 15 mm long. They are considered juveniles until they reach 25 mm long, which generally occurs in late August. Once the bay shrimp exceed 25 mm in length, they are considered adults and grow to between 35 and 50 mm long by the time they make their spawning migration out of the Golden Gate to the ocean in February.

The bay shrimp live for 1.5 to 2 years and as they grow and mature, they migrate from the shallow, less saline nursery areas to more saline and deeper waters of the South Bay. The life cycle is completed in late winter and early spring, with the seaward migration of fecund adults, resulting in the lower observed densities of this species in the South Bay and its tributaries in March and April.

4. SALINITY PREFERENCES OF BAY SHRIMP

The salinity preference of bay shrimp is apparently associated with the age and, correspondingly, the size of the individuals. A review of data collected by CDF&G between 1980 and 1995 (Baxter et al. 1999) indicates that within San Francisco Bay, juvenile bay shrimp (defined as individuals between 11 and 25 mm total length) are found at mean salinities of 10 and 13 ppt, depending upon their actual size. A figure from this paper is reproduced as Figure 2 and illustrates that there is considerable variability around these mean values and that, in fact, juveniles are found in South Bay waters with salinities as high as 17 to 19 ppt and as low as 2 to 6 ppt.

As the bay shrimp get older and larger they are found in higher salinity waters. In the months of September through February, the average size o f the bay shrimp in the potential circulation areas consistently increases from the mid 30s mm range to almost 50 mm. In the main channel of South Bay (stations SB4 and SB5), bay shrimp in this size range are commonly found at average salinities of between 17 and 27 ppt (depending upon year), and at maximum salinities of between 22 and 32 ppt (again depending upon year) (Baxter et al 1999, Kinnetic Labs 1987).
Based on these data, the preferred salinity range for juvenile bay shrimp (11-25 mm), which are found in sloughs from May through August, is approximately 10-15 ppt, with a total acceptable range of at least 2-19 ppt. For older bay shrimp (30-50 mm), which are found in sloughs from September through December, the preferred salinity range is approximately 10-20 ppt, with a total acceptable range of at least 5-25 ppt.

5. SALINITY PROFILES IN CIRCULATION AREAS

The next step in evaluating how the proposed circulation of pond water would affect the quality of the bay shrimp habitat (i.e., based on salinity preferences), is to predict salinity profiles in the proposed circulation areas during existing (i.e., no circulation) and Initial Stewardship (i.e., circulation) periods. This was accomplished in this evaluation by the use of 3-dimensional mathematical models in which bay water characteristics (e.g., salinity, velocity, tidal action), pond discharge characteristics (e.g., salinity, flow rate), and slough characteristics (e.g., depth, width) were input and 3-dimensional salinity profiles as a function of time were predicted for each slough and bay segment of interest. In these analyses, the salinity profiles that were generated for each slough were geared towards the environment primarily utilized by the bay shrimp, resulting in a longitudinal and lateral profile of the lower 25 cm of the water column.

The modeling predicted salinity profiles under existing and Initial Stewardship conditions for an entire year for each of four selected circulation locations (Alameda Flood Control Channel in the Baumberg Unit and Alviso Slough, Coyote Creek, and Guadalupe Slough in the Alviso Unit). Model runs were performed using 1994 input data – a relatively dry year. The results of the modeling effort indicated, in general, at any time during the year, the overall range of salinities did not change in a given slough between existing and Initial Stewardship conditions. However, there is a predicted upstream shift of the salinity continuum during the Initial Stewardship Period (i.e., higher salinities pushed further upstream due to the discharge of higher salinity water from the ponds into the sloughs). This general pattern was predicted for all sloughs examined and an example of this pattern is illustrated in Figure 3. In each receiving water body, the exact details of these shifts vary depending upon time of the year and initial salinity of the discharging ponds. A complete set of the longitudinal salinity profiles are provided in the accompanying modeling report.

6. PREFERRED HABITAT AREA

The final step in evaluating how the proposed circulation of pond water would affect the quality of the bay shrimp habitat is to estimate how much preferred habitat area would exist in each of the sloughs under both existing and Initial Stewardship conditions. (In this context, preferred habitat is defined as the area which experiences the preferred salinity range of the life stage that would be present at the time of the year in question. For juvenile shrimp, the preferred salinity range is 10-15 ppt and for adult shrimp, the preferred range is 10-20 ppt.) Preferred habitat was estimated by overlaying the salinity preferences of bay shrimp (as described in Section 4) onto the predicted salinity profiles (as described in Section 5). For each slough, the monthly average number of acres of "preferred habitat" was estimated under both existing and Initial Stewardship conditions.

In order to determine not only the amount of preferred shrimp habitat, but also its location, each slough was segmented into 1 km reaches prior to habitat area calculation. The boundaries of these reaches are illustrated in Figures 4-7. For each month, preferred shrimp habitat area was estimated for each of the reaches and then summed over all reaches to produce an estimate of preferred shrimp habitat in the entire slough. The use of this segmentation procedure provides a means to observe where in the slough the preferred habitat resides and how this location changes between existing and Initial Stewardship conditions.

The estimation and comparison of preferred shrimp habitat area was made for each of three sets of Initial Stewardship discharge conditions. The first set of conditions assumes that the initial releases from nine ponds (i.e., Alviso A2W, A3W, A7, A14, A16 and Baumberg 2, 2C, 8A, 11) commence simultaneously on April 1 and the salinities of the discharges are equal to those observed in 2002. The second set of conditions also assumes that the initial releases from these nine ponds commence simultaneously on April 1, but that the salinities of the discharges are at their proposed maximum values. The third set of conditions assumes that the initial releases from six ponds (i.e., Alviso A2W, A3W, A7, and Baumberg 2, 8A, 11) commence simultaneously on July 1 and the salinities of the discharges are at their proposed maximum values.

It should be noted that in the evaluations that follow, potential impacts to preferred juvenile shrimp habitat are assessed for the period May through August, even though the discharges are assumed to commence on April 1. The first month of discharge (i.e., April) is not considered because that is part of the period when the majority of bay shrimp have migrated to their ocean spawning grounds and, therefore, are not present in the sloughs.

Condition 1: Initial Discharges from 9 Ponds Simultaneously Commence on April 1 at Salinities Observed in 2002 – Monthly predictions of preferred shrimp habitat under existing and Initial Stewardship conditions were made for each of the four receiving waterbodies (i.e., the Alameda Flood Control Channel, Alviso Slough, Coyote Creek, and Guadalupe Slough) and the results are summarized in Table 1 and Figures 8-15. Detailed information for each of these waterbodies is presented in Appendices A-D.

The predictions indicate that for three of the sloughs (i.e., the Alameda Flood Control Channel, Coyote Creek, and Guadalupe Slough), the monthly mean preferred habitat area for both juvenile and adult bay shrimp is slightly higher when the ponds are discharging saline water during the Initial Stewardship Period. This means that the circulation of the saline water from the ponds does not adversely affect the amount of habitat in the 10-15 ppt salinity range during the months when juvenile shrimp are present (May-August) or the amount of habitat in the 10-20 ppt salinity range during the months when adult shrimp are present (September-February). In fact, it is predicted that the circulation of pond water under these conditions would result in a significant increase in the amount of adult preferred habitat in Guadalupe Slough. A review of the figures in Appendices A, C, and D indicate that, under these discharge conditions, during the Initial Stewardship Period there is a displacement of the preferred juvenile and adult habitat to sites further upstream in the receiving waterbodies.

For Alviso Slough, the predictions are mixed, with the monthly mean preferred habitat decreasing for juvenile bay shrimp and remaining essentially the same for adult bay shrimp when the ponds are discharging saline water during the Initial Stewardship Period. This indicates that the circulation of the saline water from the ponds may reduce habitat area in the 10-15 ppt salinity range during the months when juvenile shrimp are present (May-August) and have little effect on habitat area in the 10-20 ppt salinity range during the months when adult shrimp are present (September-February). It should be noted, however, that even though the amount of habitat in the preferred salinity range for juveniles (10-15 ppt) decreases during the Initial Stewardship Period, the amount of habitat that falls within the full range of salinities in which juveniles are known to survive (2-19 ppt) does not. Therefore, the value of the habitat may decrease for juvenile bay shrimp during the May through August period, but it is not eliminated. A review of the figures in Appendix B indicate that, under these discharge conditions, during the Initial Stewardship Period there is a displacement of preferred bay shrimp habitat to sites further upstream in Alviso Slough.

Condition 2: Initial Discharges from 9 Ponds Simultaneously Commence on April 1 at Proposed Maximum Salinities – Monthly predictions of preferred shrimp habitat under existing and Initial Stewardship conditions were made for each of the four receiving waterbodies (i.e., Alameda Flood Control Channel, Alviso Slough, Coyote Creek, and Guadalupe Slough) and the results are summarized in Table 2. The results for the juveniles (May-August) are illustrated in Figures 16-20. The results for the adults (September-February) are almost identical to those described under Condition 1 (i.e., initial release commence April 1 at 2002 salinities) and, therefore, Figures 9, 11, 13, and 15 are applicable. Detailed information for the juvenile period in each of the four waterbodies is presented in Appendices E-H. Detailed information for the adult period can be found in Appendices A-D (Figures 5-10 in each appendix).

The predictions indicate that for two of the sloughs (i.e., the Alameda Flood Control Channel and Guadalupe Slough), the monthly mean preferred habitat area for both juvenile and adult bay shrimp are not adversely impacted when the ponds are discharging saline water during the Initial Stewardship Period. This indicates that, for these two sloughs, the circulation of the saline water from the ponds is not predicted to decrease the amount of habitat in the 10-15 ppt salinity range during the months when juvenile shrimp are present (May-August) or in the 10-20 ppt salinity range during the months when adult shrimp are present (September-February). In fact, it is predicted that, under these discharge conditions, the adult preferred habitat area may significantly increase in Guadalupe Slough during the Initial Stewardship Period. A review of Appendix E (Figures 1-4 for juveniles) and Appendix A (Figures 5-10 for adults) indicates that there is a displacement of the preferred shrimp habitat to sites further upstream in the Alameda Flood Control Channel during the Initial Stewardship Period. A similar pattern is observed in

Guadalupe Slough by reviewing Appendix H (Figures 1-4 for juveniles) and Appendix D (Figures 5-10 for adults).

For the other two sloughs (Alviso Slough and Coyote Creek) the pattern is predicted to be somewhat different. During the May through August period, when the juvenile life stage is present, it is predicted that the discharge from the ponds will result in a decrease in preferred habitat area in the 10-15 ppt salinity range. However, later in the season when the adult life stage is present (September – February), the discharge will have no effect on preferred habitat area in the 10-20 ppt salinity range. A review of the figures in Appendices F and G indicate that there is a displacement of the preferred juvenile shrimp habitat to sites further upstream in Alviso Slough and Coyote Creek during the Initial Stewardship Period. As illustrated in Appendices B and C (Figures 5-10 in each appendix), this upstream displacement is predicted to continue, but to a lesser extent, through the September-February period, when adult shrimp are present.

Condition 3: Initial Discharges from 6 Ponds Simultaneously Commence on July 1 at Proposed Maximum Salinities (termed Phased Initial Release) – Monthly predictions of preferred shrimp habitat under existing and Initial Stewardship conditions were made for each of three receiving waterbodies (i.e., Alviso Slough, Coyote Creek, and Guadalupe Slough) and the results are summarized in Table 3. The results for the juveniles (July-August) are illustrated in Figures 20-22. The results for the adults (September-February) are almost identical to those described under Condition 1 (i.e., initial release commence April 1 at 2002 salinities) and, therefore, Figures 9, 11, 13, and 15 are applicable. Detailed information for the juvenile period in each of the three waterbodies is presented in Appendices I-K. Detailed information for the adult period can be found in Appendices B-D (Figures 5-10 in each appendix).

The predictions indicate that for Coyote Creek the monthly mean preferred habitat area for both juvenile and adult bay shrimp are virtually unchanged when the ponds are discharging saline water during the Initial Stewardship Period. This indicates that, for this creek, the circulation of the saline water from the ponds is not expected to change the same amount of habitat area in the 10-15 ppt salinity range during the months when juvenile shrimp are present (May-August) or in the 10-20 ppt salinity range during the months when adult shrimp are present (September-February). A review of Appendix J (Figures 1-3 for juveniles) and Appendix C (Figures 5-10 for adults) indicate that there is a slight displacement of the preferred shrimp habitat to sites further upstream in Coyote Creek during the Initial Stewardship Period.

For the other two sloughs (Alviso Slough and Guadalupe Slough) the pattern is predicted to be somewhat different. During the July through August period, when the juvenile life stage is present, it is predicted that the discharge from the ponds will result in a decrease in preferred habitat area in the 10-15 ppt salinity range. However, later in the season when the adult life stage is present (September – February), the discharges will not have a detrimental effect on preferred habitat area in the 10-20 ppt salinity range. In fact, it is predicted that the adult preferred habitat area in Guadalupe Slough may actually increase by a considerable amount. A review of Appendix I (Figures 1-3 for juveniles) and Appendix B (Figures 5-10 for adults) indicates that there is a displacement of the preferred shrimp habitat to sites further upstream in Alviso Slough during the Initial Stewardship Period. A similar pattern is observed in Guadalupe Slough by reviewing Appendix K (Figures 1-3 for juveniles) and Appendix D (Figures 5-10 for adults).

7. CONCLUSIONS

It is clear that bay shrimp use the sloughs into which saline pond water will be circulated during the Initial Stewardship Period as rearing habitat. The use is seasonal, with most shrimp being absent during the months of March and April. This two month period encompasses the time when the adults leave the South Bay to spawn in the ocean. In May, the young-of-the-year return to the sloughs to grow and mature until February when their annual migration to the ocean once again begins. In order to minimize any potential impacts to bay shrimp, this window of low abundance (March and April) would be an ideal time to initiate the circulation of saline water from the ponds. The discharged pond water will have the highest salinities at the beginning of the Initial Stewardship Period and an opportunity to eliminate those more saline waters when the majority of the shrimp are absent would be advantageous.

Based on the salinity preferences of the various life stages of bay shrimp and model predictions of salinity profiles, it appears that, if the discharges commence in April at salinities observed in 2002, the circulation of saline water from the ponds will not significantly alter the overall habitat value for bay shrimp in the sloughs in question. For all four sloughs examined, the amount of preferred habitat for the adults is predicted to remain unchanged or, in the case of Guadalupe Slough, increase during the Initial Stewardship Period. Similarly, for three of these four sloughs, the amount of preferred habitat for juveniles will remain relatively unchanged during the Initial Stewardship Period. In Alviso Slough, where there is a predicted decrease in the amount of preferred juvenile habitat area (i.e., Alviso Slough), the resulting habitat value may be decreased, but would not be eliminated. Under this set of discharge conditions, in almost all months in each of the sloughs, the major effect will not be the loss of preferred habitat, but rather a shift of the preferred salinities to locations further upstream.

If the discharges commence in April at their proposed maximum salinities, conclusions on potential impacts to bay shrimp habitat do not change significantly. Under these conditions, there is no predicted reduction in the amount of adult preferred habitat area in any of the four sloughs studied. In addition, for two of the sloughs (the Alameda Flood Control Channel and Guadalupe Slough) there is no predicted reduction in the amount of juvenile preferred habitat either. On the other hand, for Alviso Slough and Coyote Creek, discharges under these conditions are predicted to reduce the amount of preferred juvenile habitat, but the lost area will still retain some value to the juvenile shrimp. It should be pointed out that, according to these predictions, increasing the discharge salinities from 2002 levels to maximum proposed levels resulted in relatively little additional habitat loss for bay shrimp. Under this set of discharge conditions, in almost all months in each of the sloughs, the major effect will not be the loss of preferred habitat, but rather a shift of the preferred salinities to locations further upstream.

If the discharges commence in July at their proposed maximum salinities, conclusions on potential impacts to bay shrimp habitat change to a greater extent. Under these conditions, there is no predicted reduction in the amount of adult preferred habitat in any of the three sloughs studied. In addition, for Coyote Creek there is little predicted change in the amount of juvenile preferred habitat either. On the other hand, for Alviso Slough and Guadalupe Slough, discharges under these conditions are predicted to reduce the amount of preferred juvenile habitat. However, it should be noted that even though some habitat in these sloughs will now fall out of the preferred juvenile salinity range, this habitat will still maintain some value to juvenile bay shrimp.

In summary, this evaluation indicates that, with regard to bay shrimp habitat, the major change that the circulation of saline pond water will produce during the Initial Stewardship Period is a shift of the most preferred salinities to locations further upstream in the sloughs in question. Overall, if discharges are at 2002 salinities, the amount of habitat that will have the preferred salinity ranges for both juveniles and adults will not decrease. If the discharges are at proposed maximum salinities and/or the initial release is delayed until July, there is a predicted decrease in juvenile preferred habitat in Alviso Slough and Guadalupe Slough during the Initial Release Period, but adult preferred habitat is not expected to be affected. After the initial release from the ponds has been completed, it is anticipated that juvenile and adult shrimp habitat in the sloughs will not be significantly impacted by the planned continuous circulation of relatively low salinity pond water.

8. LITERATURE CITED

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Hatfield, S. 1985. Seasonal and Interannual Variation in distribution and population abundance of the shrimp Crangon franciscorum in San Francisco Bay. Hydrobiologia 129: 199-210.

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Table 1. Estimated Area of Preferred Bay Shrimp Habitat under Existing and Initial Stewardship Conditions (Initial Discharge at 2002 Salinities)

Month[d]	Area of Preferred Habitat (Acres)[c]							
	Alameda FCC		Alviso Slough		Coyote Creek		Guadalupe Slough	
	Existing	Stewardship	Existing	Stewardship	Existing	Stewardship	Existing	Stewardship
May	10.2	12.2	35.0	52.5	175	205	29.1	65.5
June	9.4	10.8	65.4	22.2	165	176	47.8	41.1
July	9.7	11.7	75.5	23.3	159	157	48.6	40.9
Aug	9.9	10.1	68.7	24.2	149	145	53.7	46.3
μ Juvenile[a]	**9.7**	**11.0**	**61.2**	**30.6**	**162**	**171**	**44.8**	**48.5**
Sept	19.6	20.2	130	50.3	307	323	79.4	90.8
Oct	18.7	19.6	87.1	88.8	310	334	68.3	91.2
Nov	26.6	27.4	62.6	86.7	405	426	61.5	138
Dec	33.9	35.2	66.2	99.7	459	469	73.4	158
Jan	25.5	25.5	17.2	20.4	554	555	39.6	50.3
Feb	46.3	47.5	5.1	6.7	597	630	16.0	23.0
μ Adult[b]	**28.4**	**29.2**	**61.3**	**58.8**	**439**	**456**	**56.4**	**91.7**

[a] **μ Juvenile = Average monthly area during May–August, when the juvenile life stage is present**

[b] **μ Adult = Average monthly area during September-February, when the adult life stage is present**

[c] **Preferred habitat is defined as the area that experiences the preferred salinity range for the lifestage; the preferred salinity range for juveniles is 10-15 ppt and for adults is 10-20 ppt**

[d] **March and April are not included because bay shrimp have low abundances in the sloughs during those months**

Table 2. Estimated Area of Preferred Bay Shrimp Habitat under Existing and Stewardship Conditions (Initial Discharge at Maximum Proposed Salinity)

Month[d]	Area of Preferred Habitat (Acres)[c]							
	Alameda FCC		Alviso Slough		Coyote Creek		Guadalupe Slough	
	Existing	Stewardship	Existing	Stewardship	Existing	Stewardship	Existing	Stewardship
May	10.2	8.4	35.0	19.9	175	103	29.1	30.2
June	9.4	9.6	65.4	18.0	165	142	47.8	43.5
July	9.7	11.4	75.5	23.2	159	144	48.6	48.3
Aug	9.9	10.1	68.7	24.0	149	145	53.7	51.1
μ Juvenile[a]	**9.8**	**9.9**	**61.2**	**21.3**	**162**	**134**	**44.8**	**43.3**
Sept	19.6	20.2	130	52.5	307	322	79.4	85.6
Oct	18.7	19.6	87.1	88.8	310	334	68.3	91.2
Nov	26.6	27.4	62.6	86.7	405	426	61.5	138
Dec	33.9	35.2	66.2	99.7	459	469	73.4	158
Jan	25.5	25.5	17.2	20.4	554	555	39.6	50.3
Feb	46.3	47.5	5.1	6.7	597	630	16.0	23.0
μ Adult[b]	**28.4**	**29.2**	**61.3**	**58.8**	**439**	**456**	**56.4**	**91.7**

[a] **μ Juvenile = Average monthly area during May–August, when the juvenile life stage is present**

[b] **μ Adult = Average monthly area during September-February, when the adult life stage is present**

[c] **Preferred habitat is defined as the area that experiences the preferred salinity range for the lifestage; the preferred salinity range for juveniles is 10-15 ppt and for adults is 10-20 ppt**

[d] **March and April are not included because bay shrimp have low abundances in the sloughs during those months**

Table 3. Estimated Area of Preferred Bay Shrimp Habitat under Existing and Stewardship Conditions (Phased Initial Discharge at Maximum Proposed Salinity)

Month[d]	Area of Preferred Habitat (Acres)[c]							
	Alameda FCC		Alviso Slough		Coyote Creek		Guadalupe Slough	
	Existing	Stewardship	Existing	Stewardship	Existing	Stewardship	Existing	Stewardship
May			35.0		175		29.1	
June			65.4		165		47.8	
July			75.5	10.4	159	136	48.6	15.6
Aug			68.7	10.4	149	128	53.7	14.4
µ Juvenile[a]			**72.1[e]**	**10.4[e]**	**154[e]**	**132[e]**	**51.1[e]**	**15.0[e]**
Sept			130	47.2	307	288	79.4	71.7
Oct			87.1	88.8	310	334	68.3	91.2
Nov			62.6	86.7	405	426	61.5	138
Dec			66.2	99.7	459	469	73.4	158
Jan			17.2	20.4	554	555	39.6	50.3
Feb			5.1	6.7	597	630	16.0	23.0
µ Adult[b]			**61.3**	**58.3**	**439**	**450**	**56.4**	**88.7**

[a] **µ Juvenile = Average monthly area during May–August, when the juvenile life stage is present**

[b] **µ Adult = Average monthly area during September-February, when the adult life stage is present**

[c] **Preferred habitat is defined as the area that experiences the preferred salinity range for the lifestage; the preferred salinity range for juveniles is 10-15 ppt and for adults is 10-20 ppt**

[d] **March and April are not included because bay shrimp have low abundances in the sloughs during those months**

[e] **µ Juvenile = Average monthly area during July-August because phased initial release does not start until July**

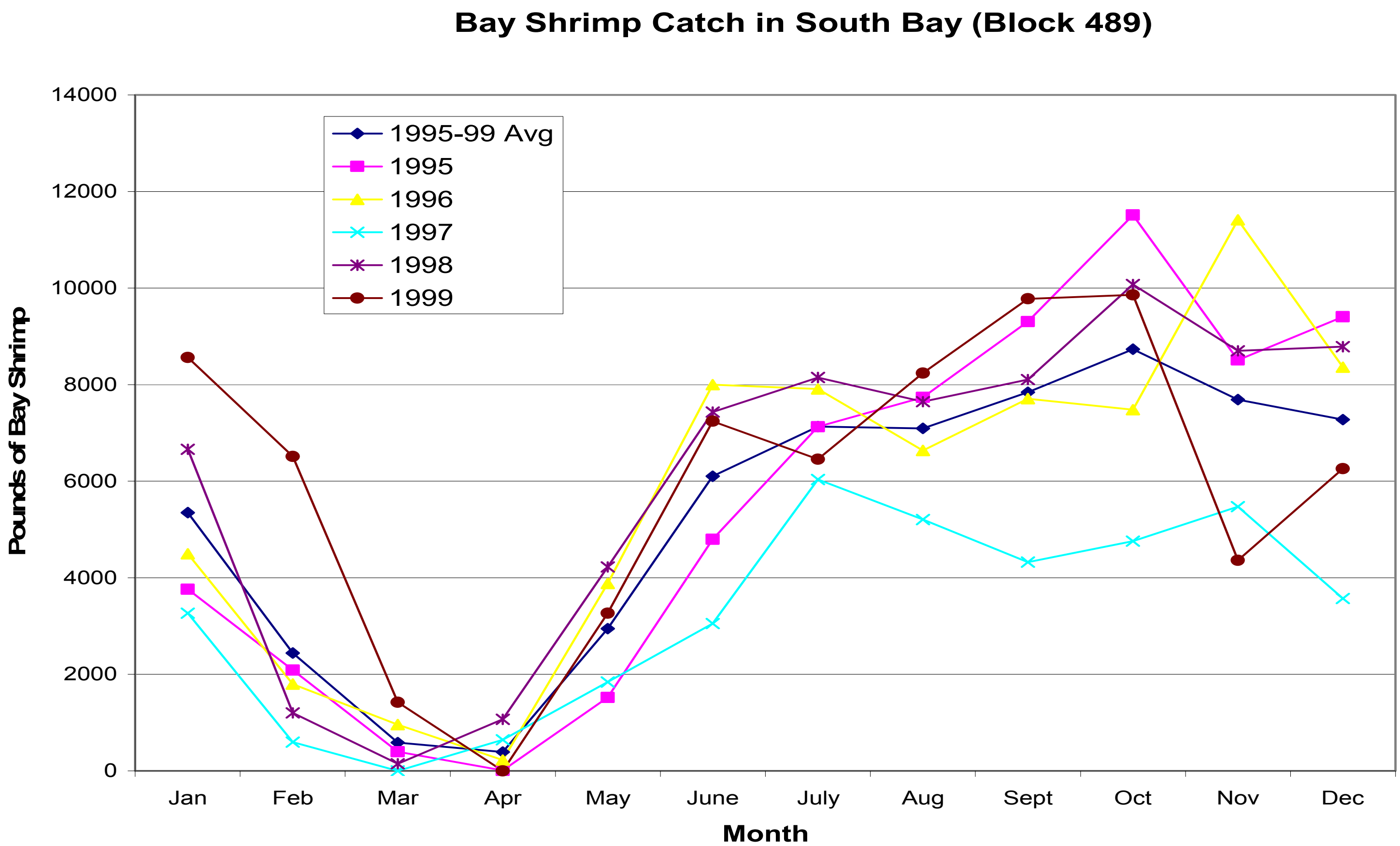


Figure 1. Temporal pattern of shrimp abundance in South Bay (data from S. Ashcraft, CDF&G, Belmont, CA)

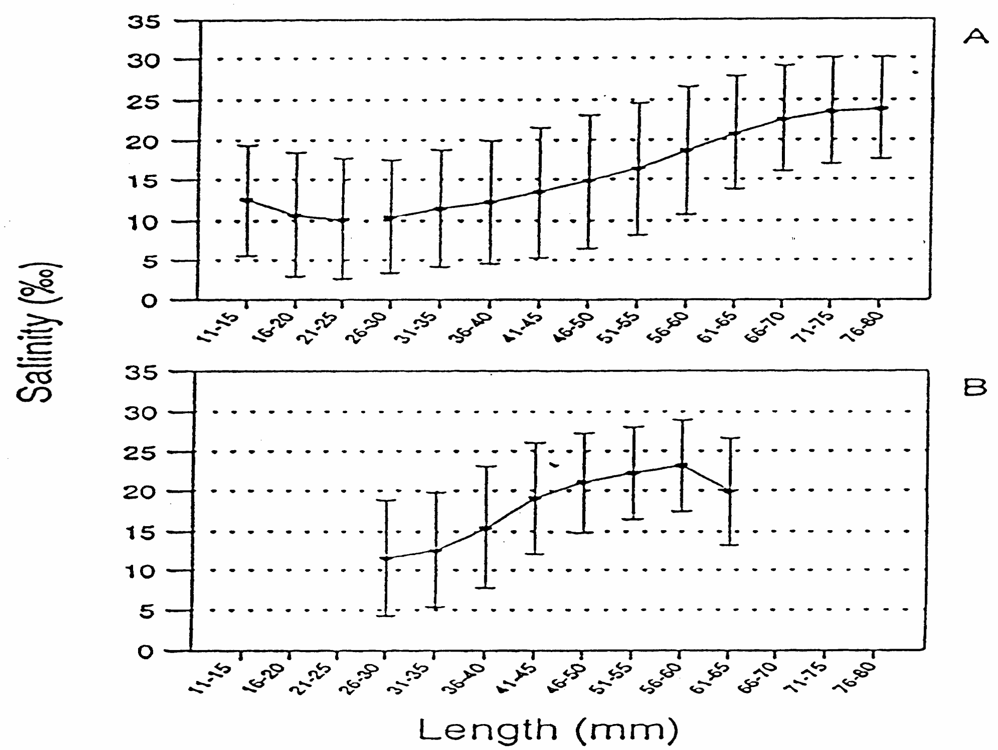
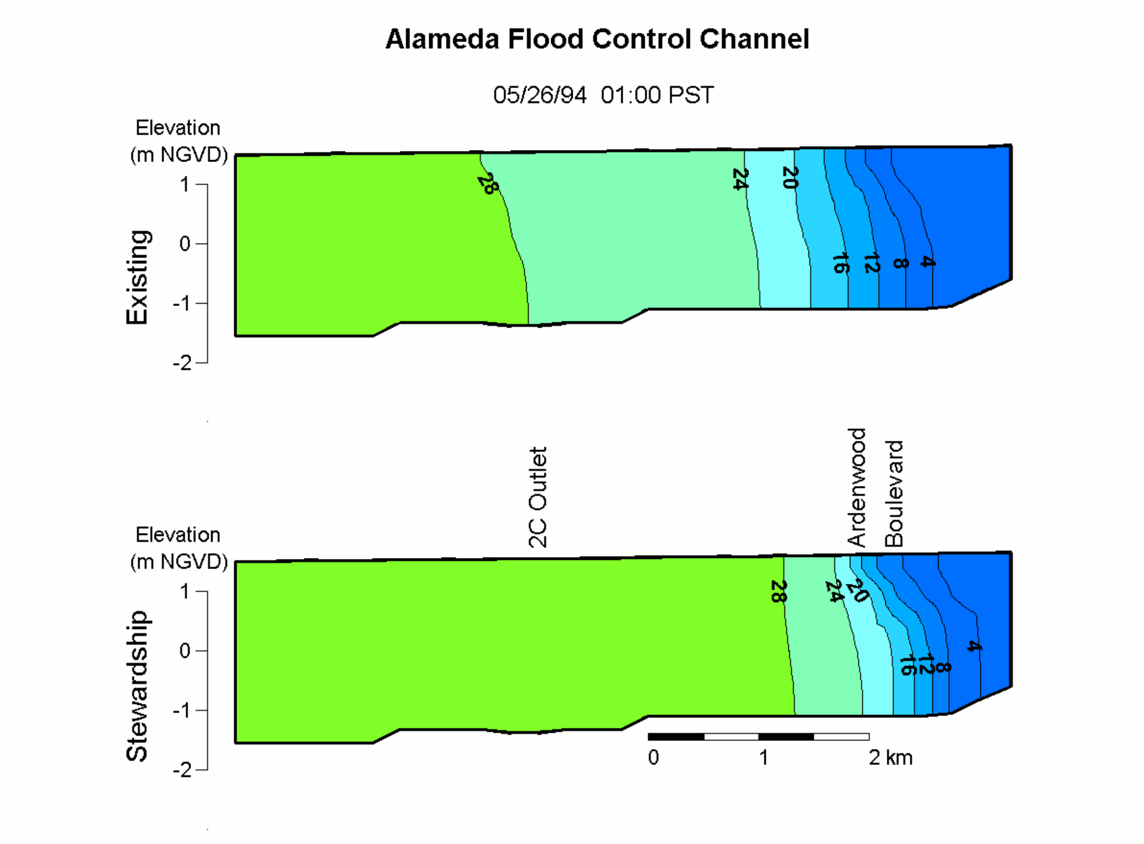


Figure 2. Salinity preferences for bay shrimp as a function of length
(A) For juveniles (11-25 mm) & females (26-80 mm)
(B) For males (26-65 mm)

(from Baxter et al., page 88, Figure 11)



Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994-1995 weather and tidal conditions.

Figure 3. An example of the predicted longitudinal salinity profiles under existing and Initial Stewardship Conditions. This figure illustrates predictions for the Alameda Flood Control Channel during the eighth week of the Initial Release Period assuming Pond 2C commenced discharge at its Proposed Maximum Salinity.

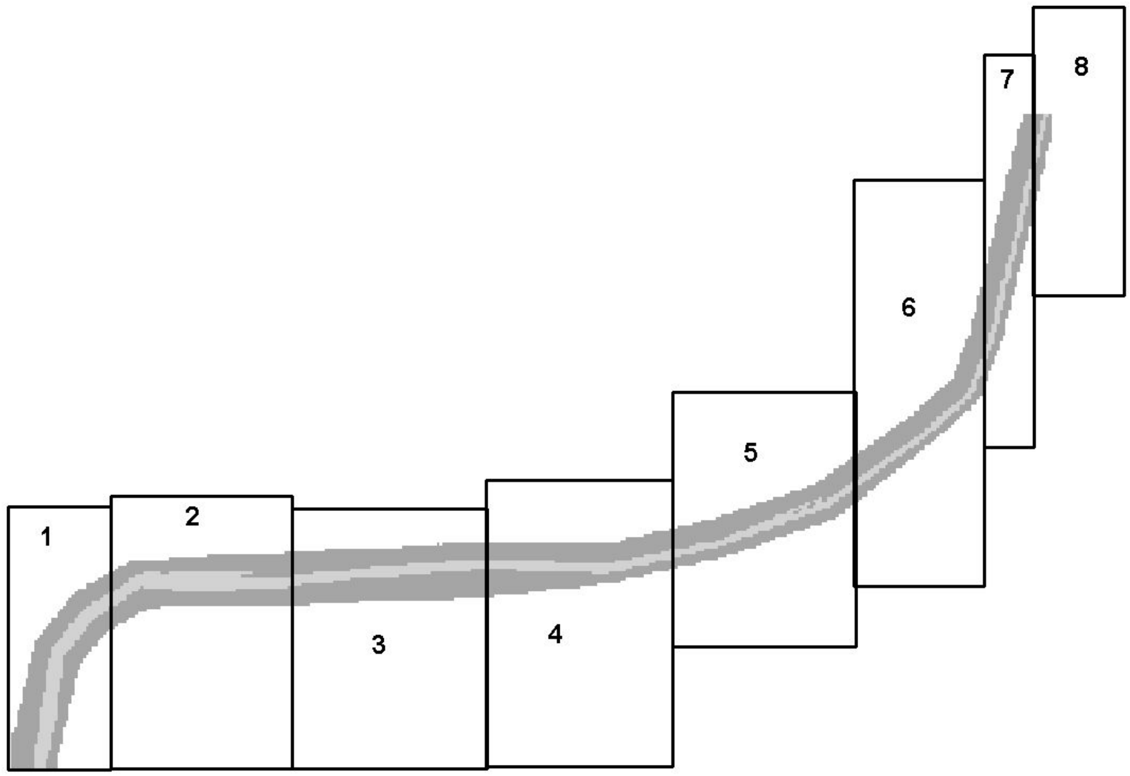


Figure 4. One Kilometer Reaches in Alameda Flood Control Channel.

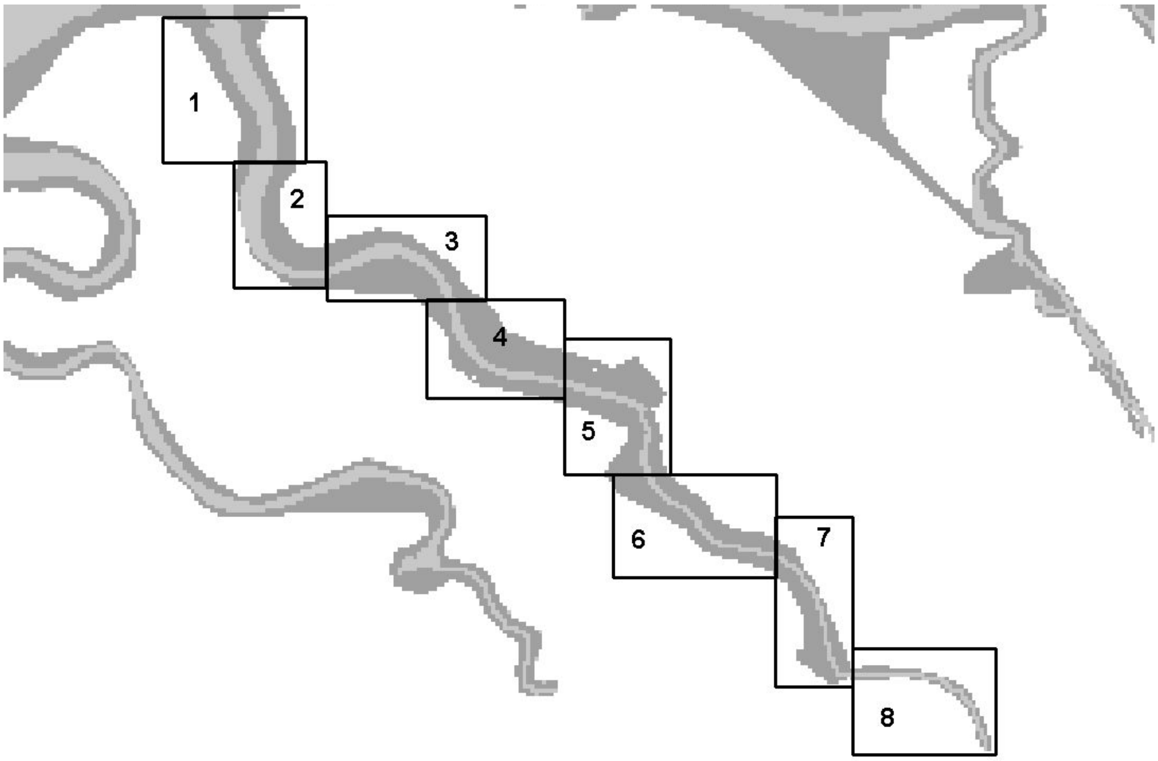


Figure 5. One Kilometer Reaches in Alviso Slough.

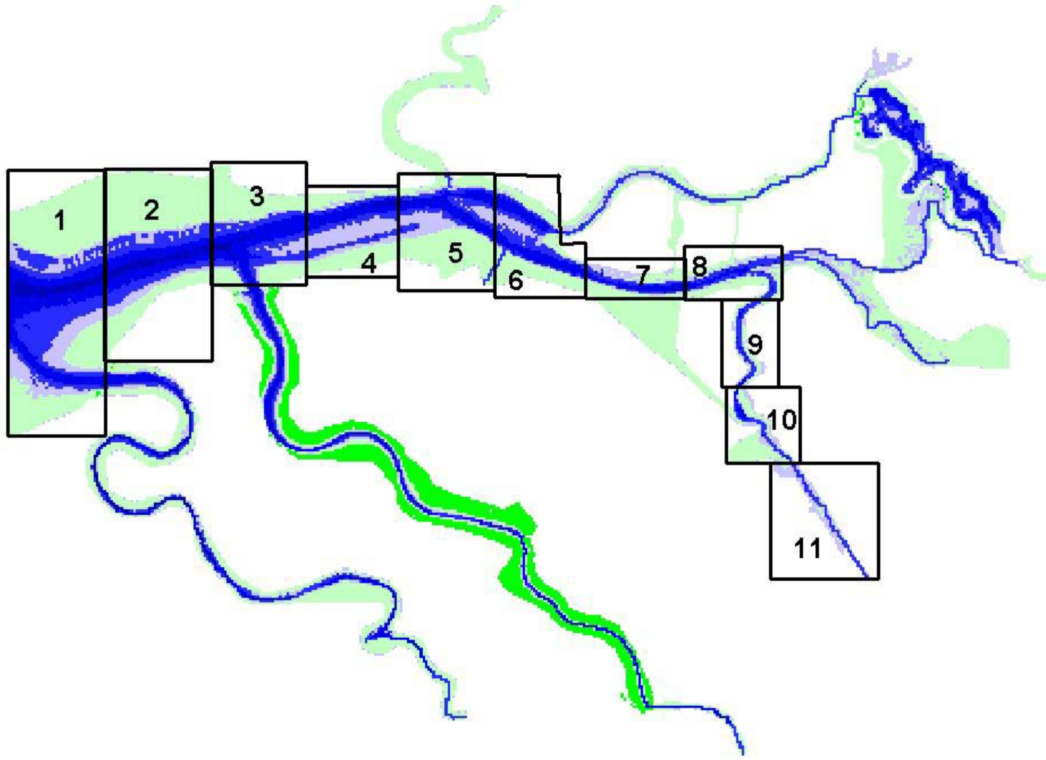


Figure 6. One Kilometer Reaches in Coyote Creek and Artesian Slough.

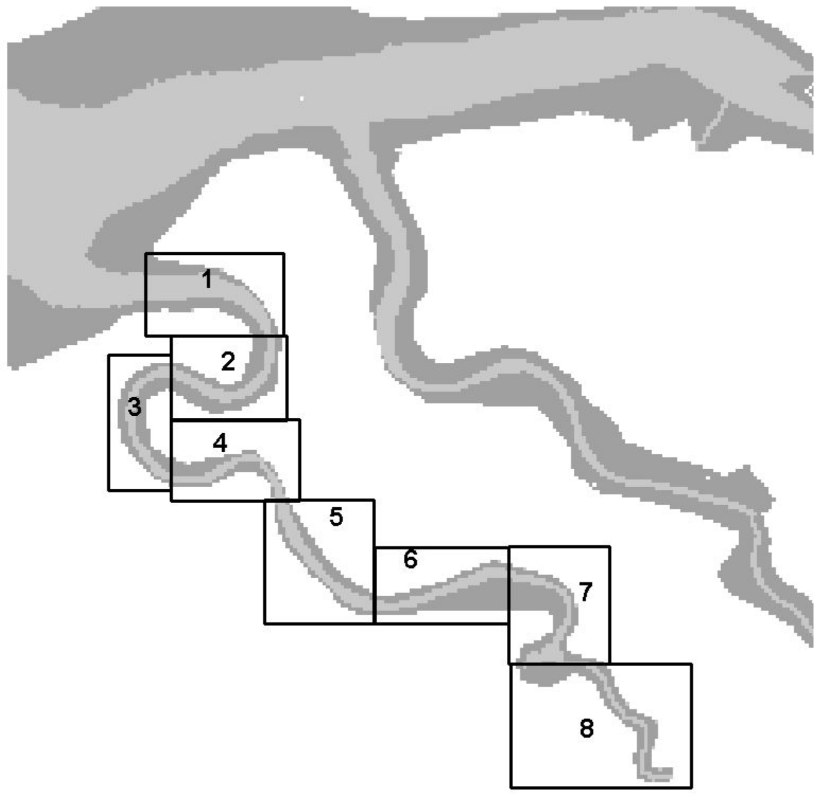
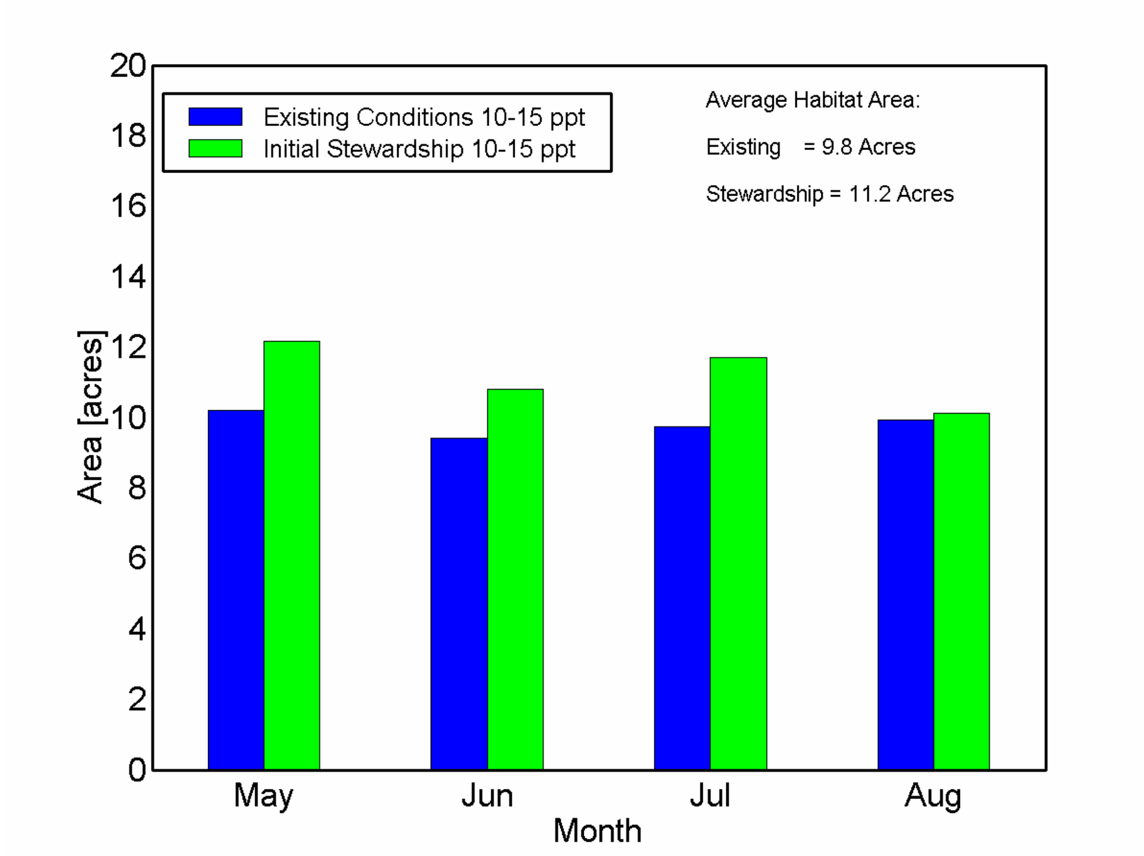
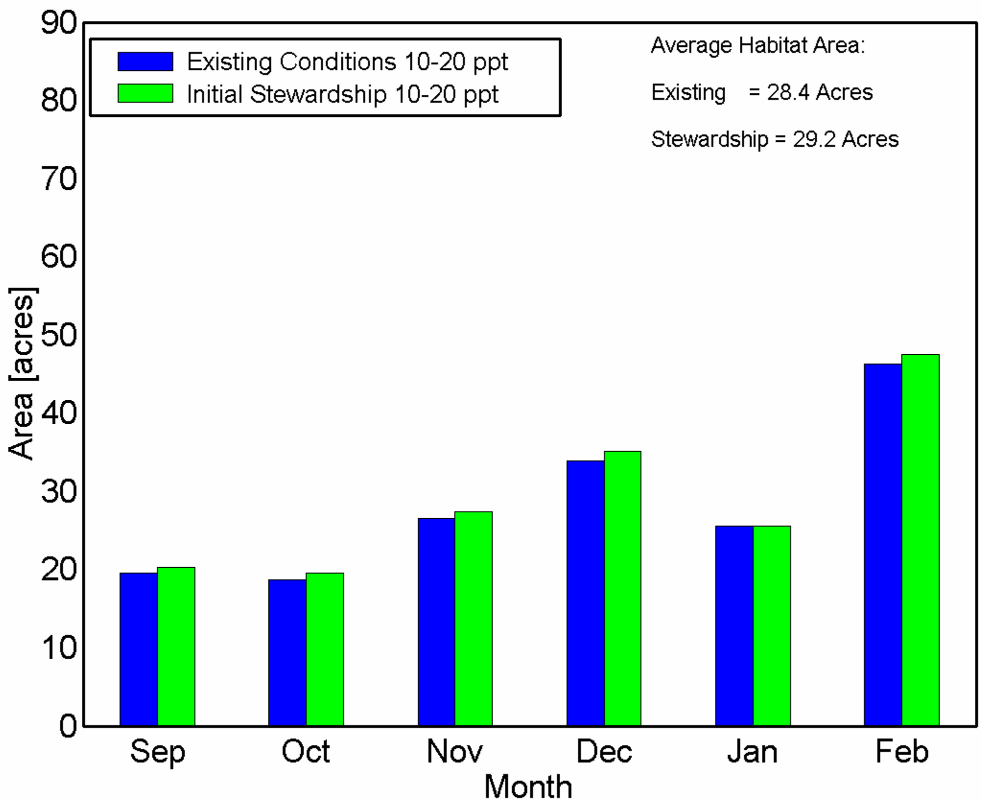


Figure 7. One Kilometer Reaches in Guadalupe Slough.



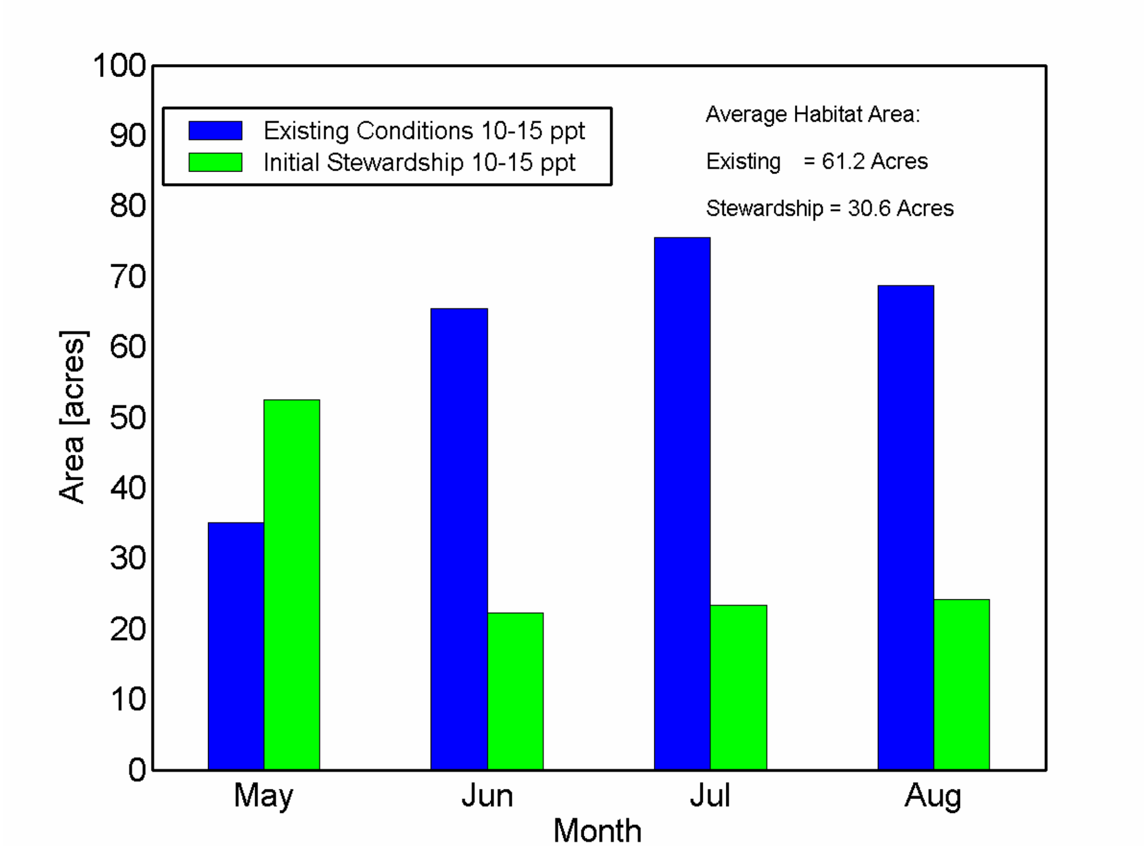
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994-1995 weather and tidal conditions.

Figure 8. Predicted juvenile bay shrimp preferred habitat area in the Alameda Flood Control Channel for the period May through August. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



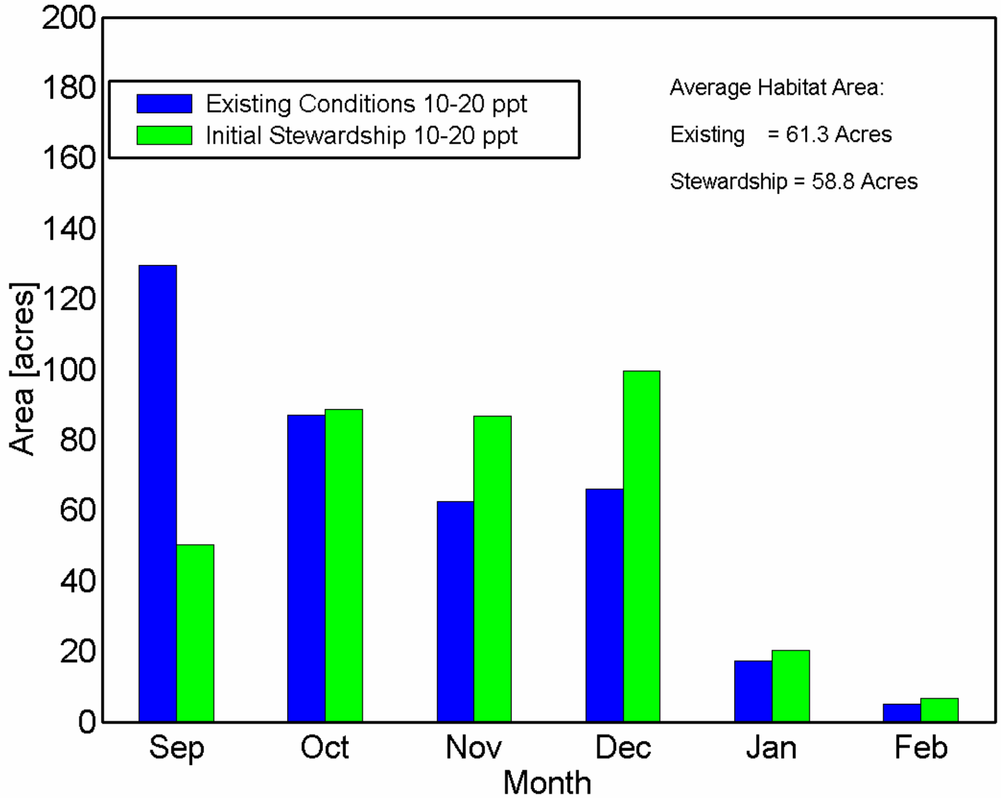
Note: Adult bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 20 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 9. Predicted adult bay shrimp preferred habitat area in the Alameda Flood Control Channel for the period September through February. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



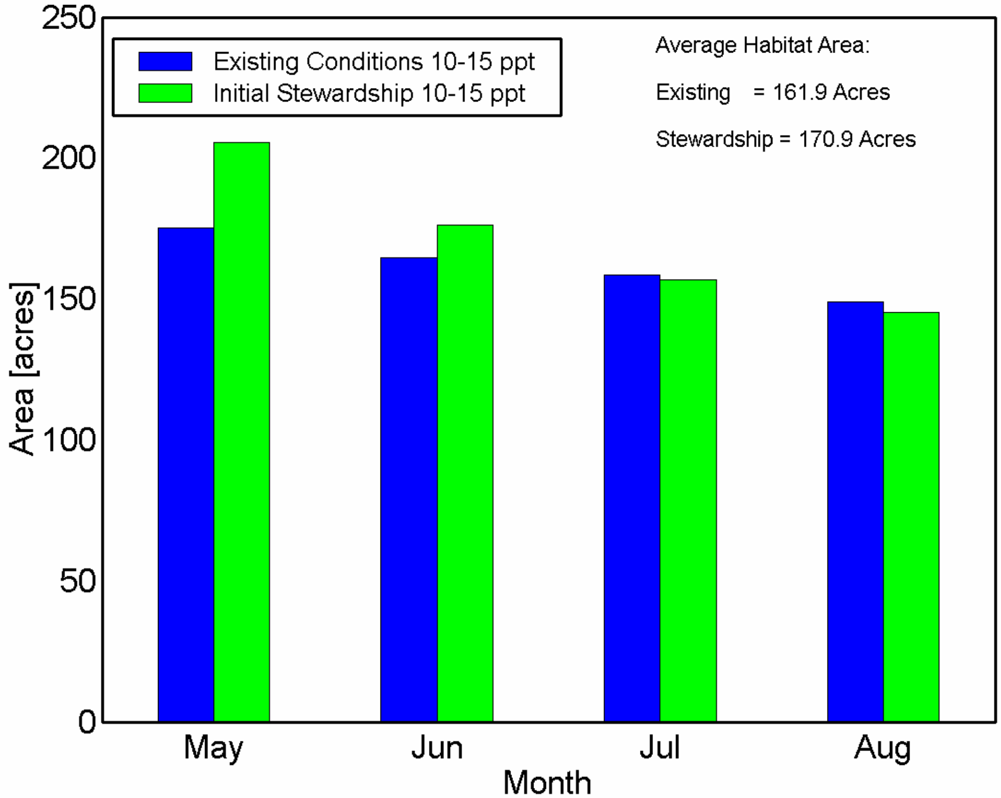
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 10. Predicted juvenile bay shrimp preferred habitat area in Alviso Slough for the period May through August. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



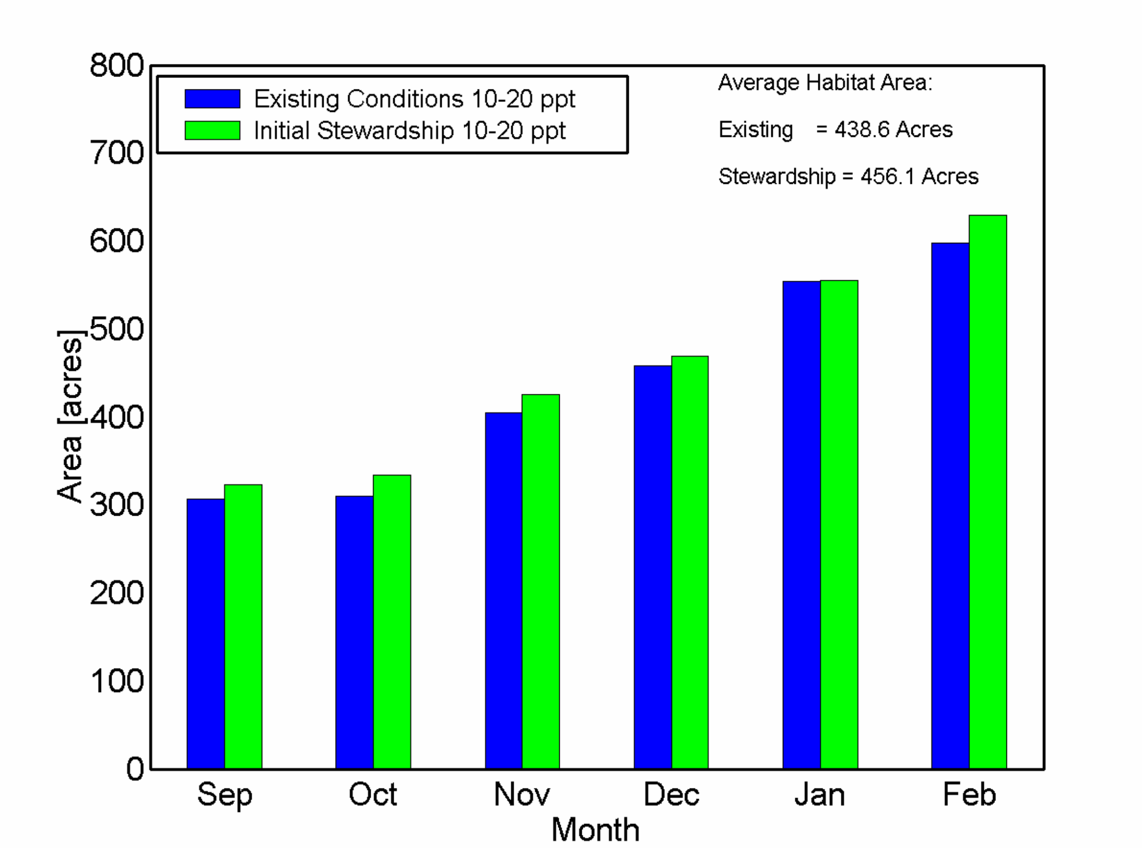
Note: Adult bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 20 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 11. Predicted adult bay shrimp preferred habitat area in Alviso Slough for the period September through February. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



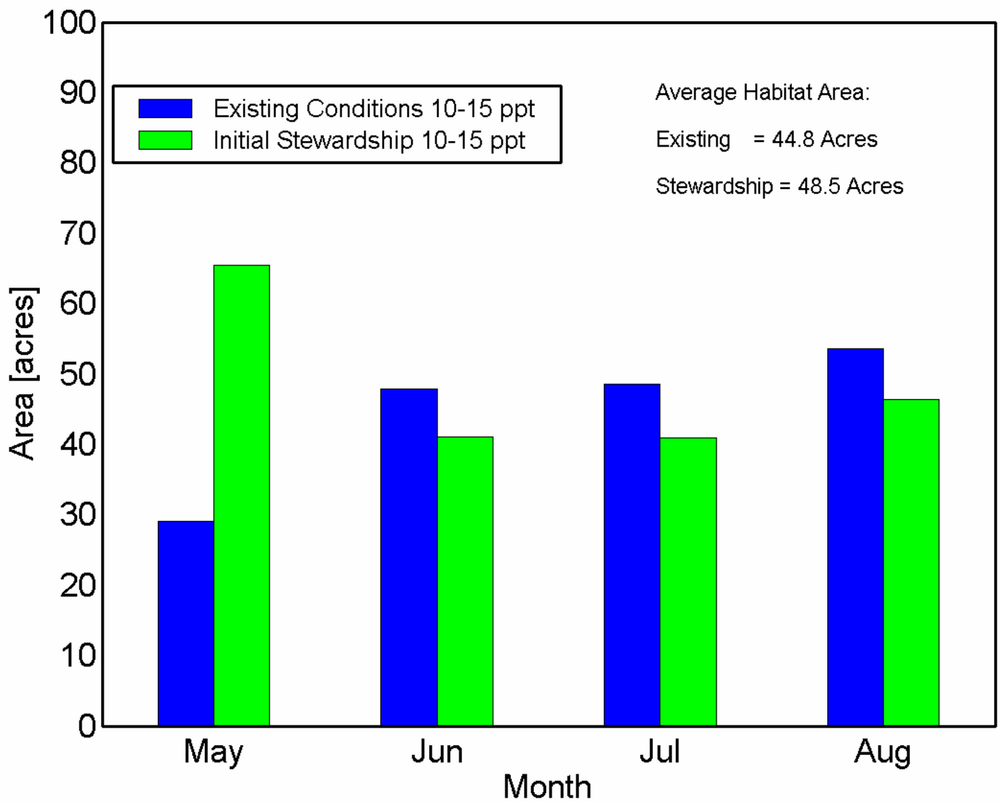
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 12. Predicted juvenile bay shrimp preferred habitat area in Coyote Creek for the period May through August. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



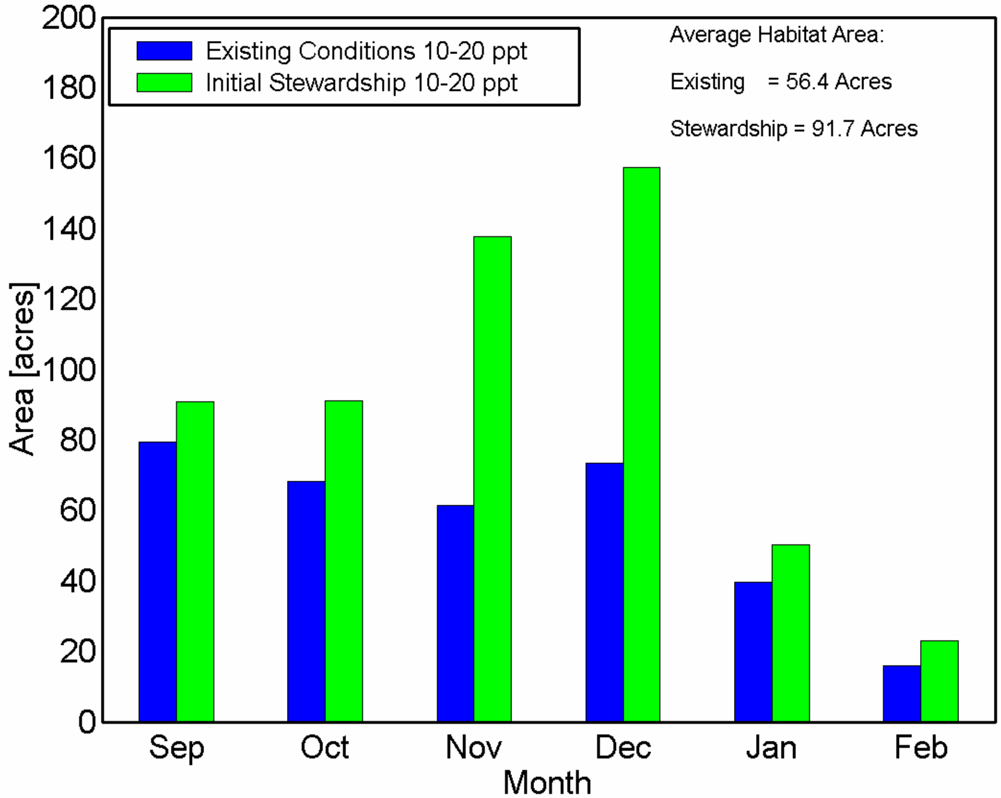
Note: Adult bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 20 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 13. Predicted adult bay shrimp preferred habitat area in Coyote Creek for the period September through February. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



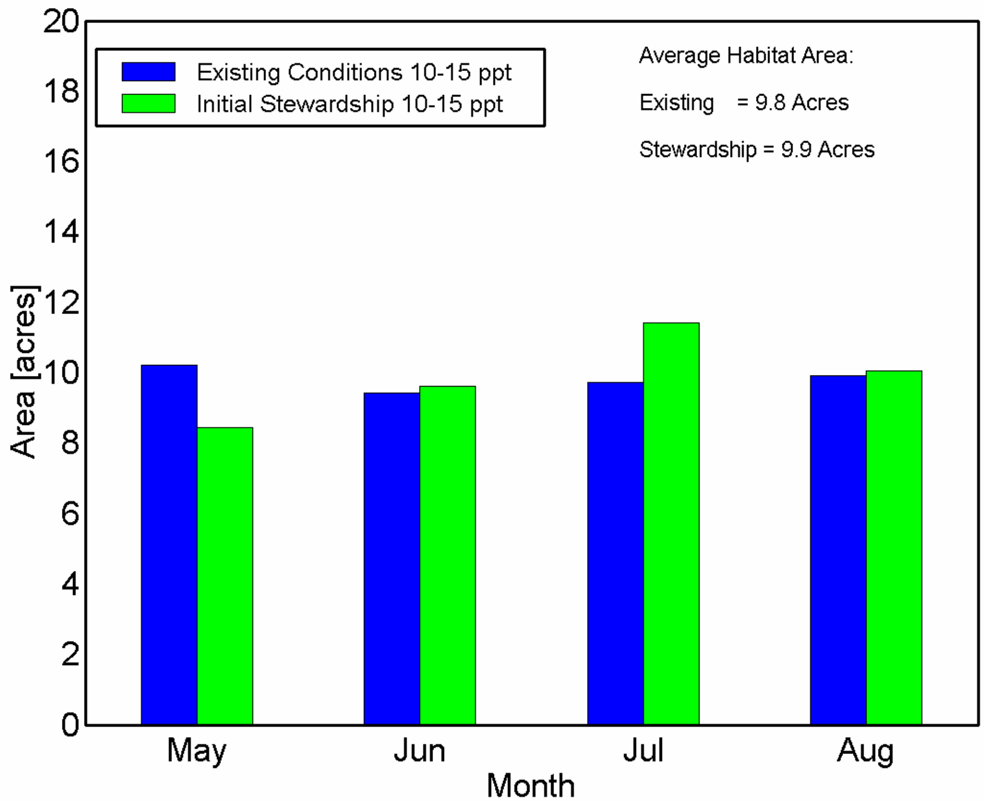
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 14. Predicted juvenile bay shrimp preferred habitat area in Guadalupe Slough for the period May through August. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



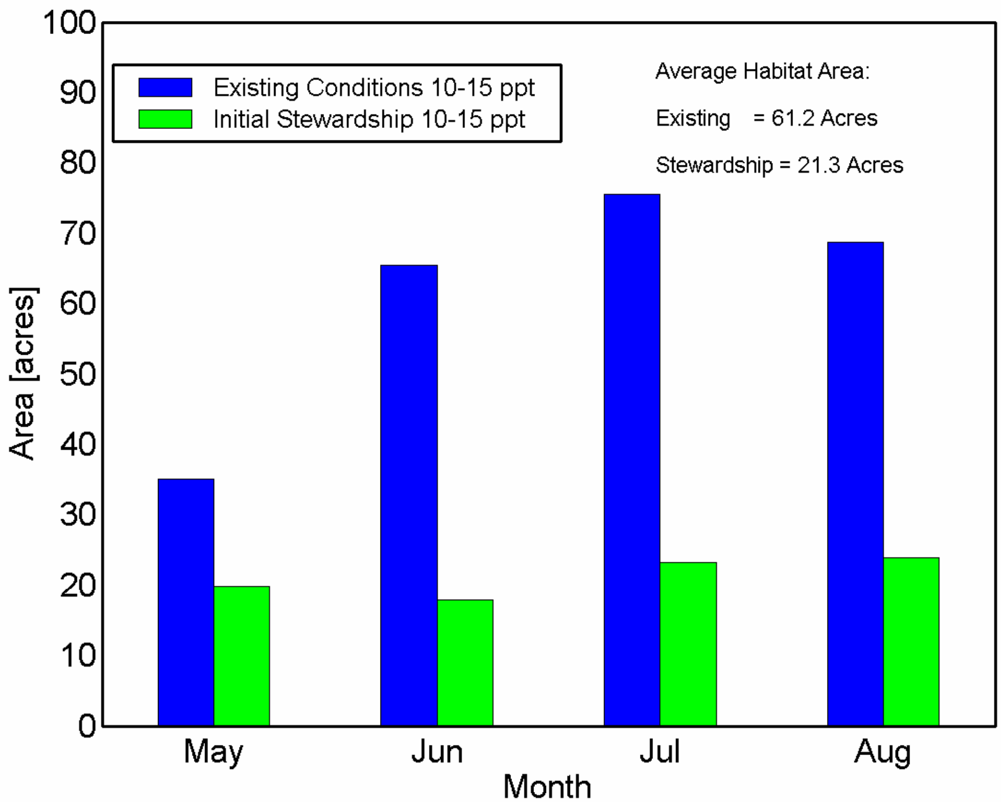
Note: Adult bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 20 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Figure 15. Predicted adult bay shrimp preferred habitat area in Guadalupe Slough for the period September through February. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



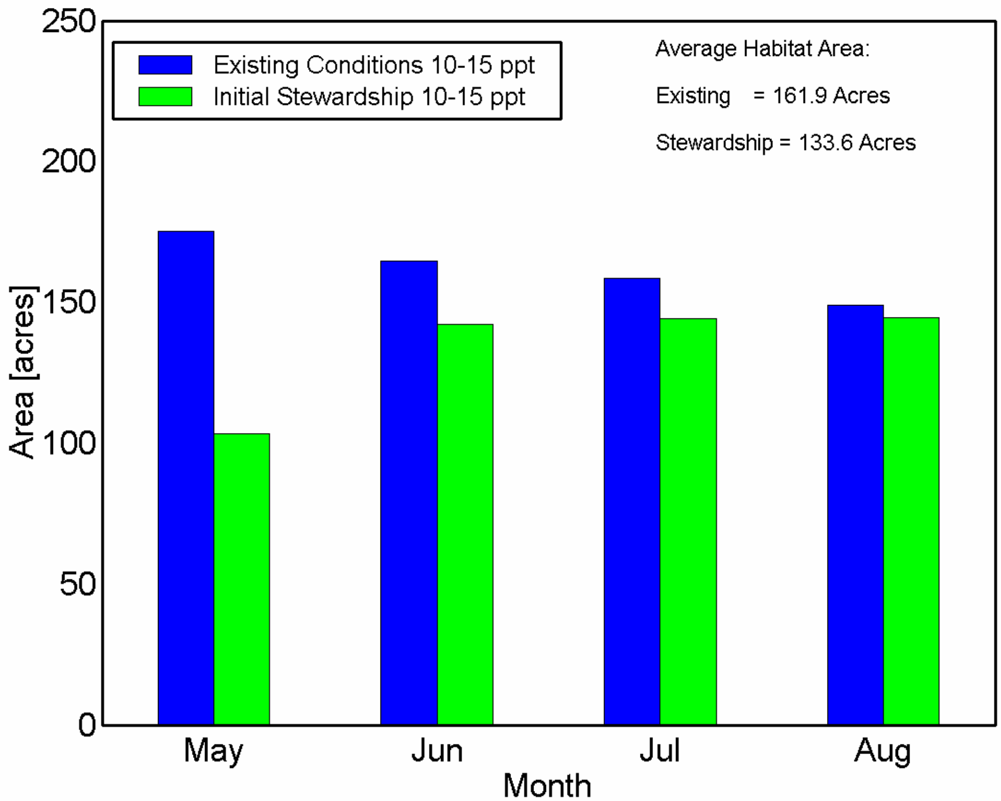
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994-1995 weather and tidal conditions.

Figure 16. Predicted juvenile bay shrimp preferred habitat area in the Alameda Flood Control Channel for the period May through August. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at proposed maximum salinities.



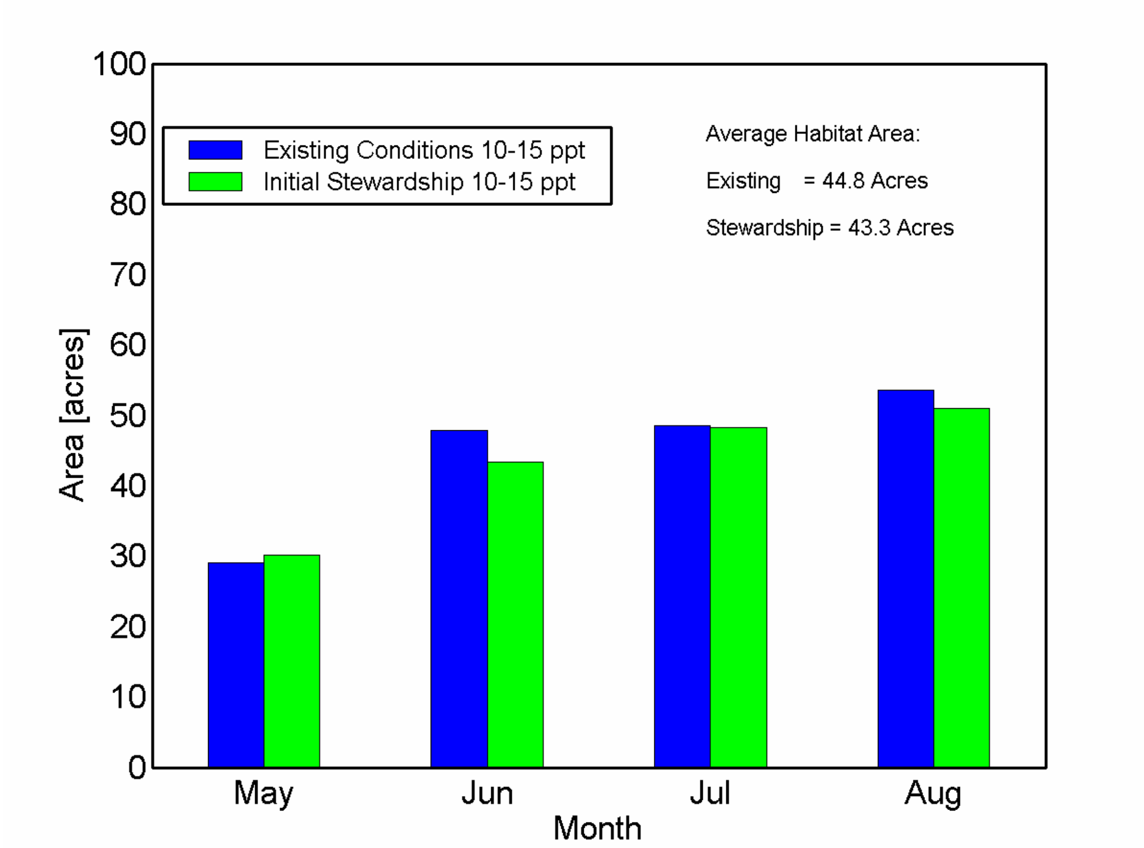
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994-1995 weather and tidal conditions.

Figure 17. Predicted juvenile bay shrimp preferred habitat area in Alviso Slough for the period May through August. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at proposed maximum salinities.



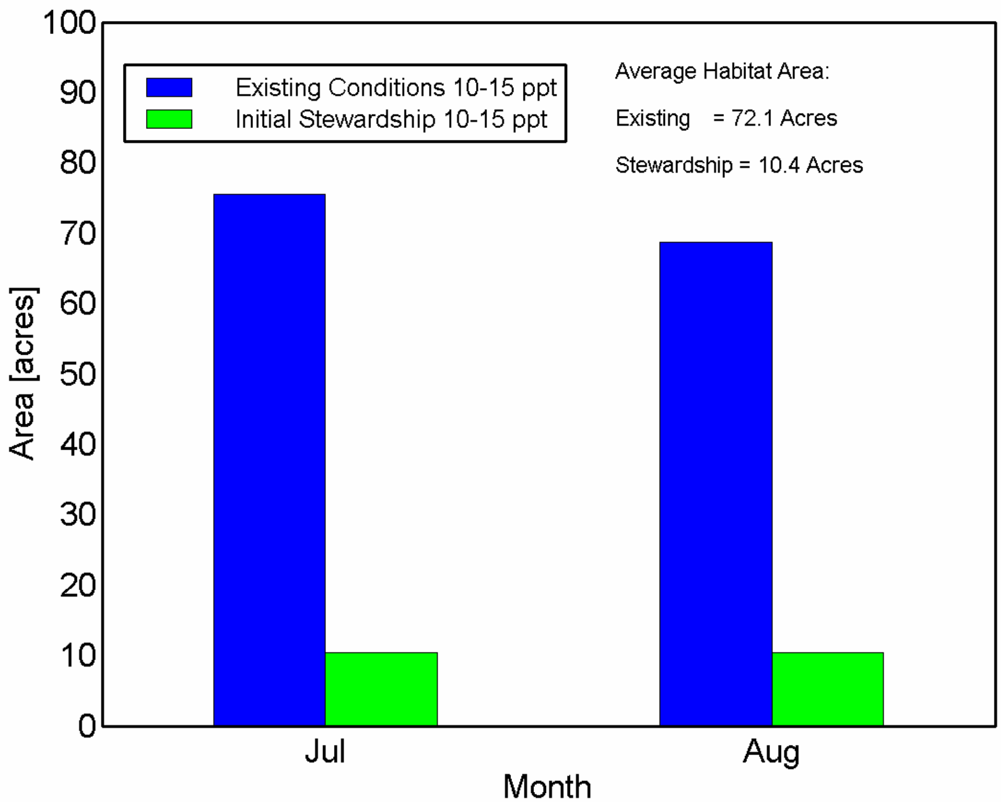
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994-1995 weather and tidal conditions.

Figure 18. Predicted juvenile bay shrimp preferred habitat area in Coyote Creek for the period May through August. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at proposed maximum salinities.



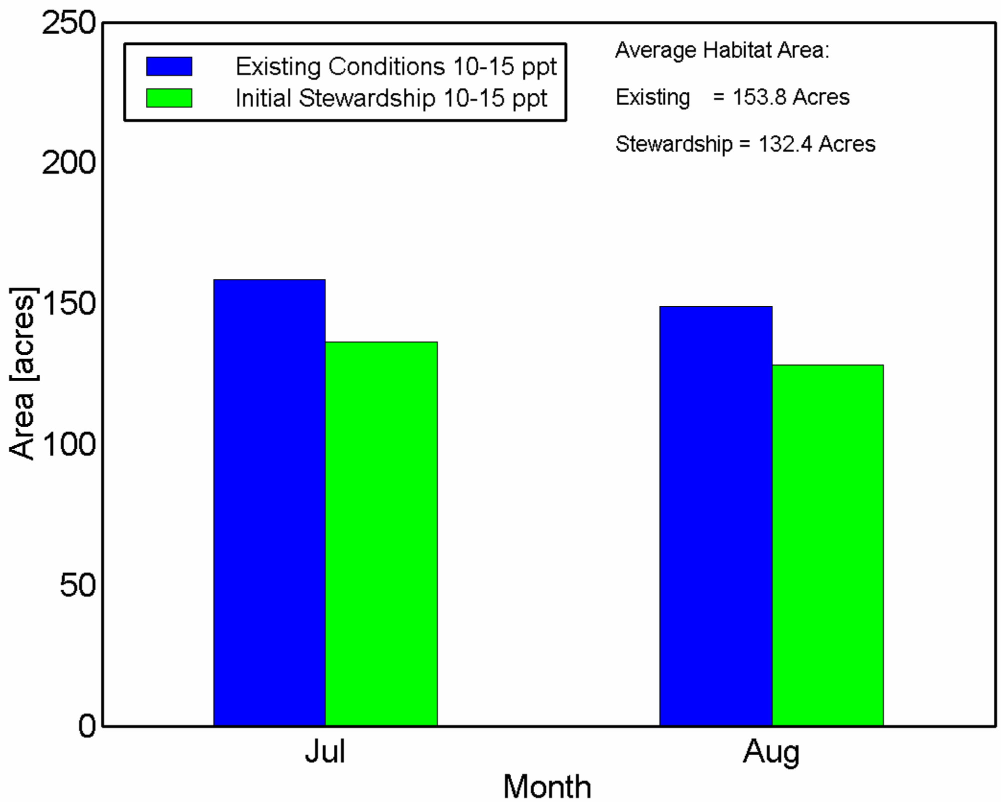
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994-1995 weather and tidal conditions.

Figure 19. Predicted juvenile bay shrimp preferred habitat area in Guadalupe Slough for the period May through August. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at proposed maximum salinities.



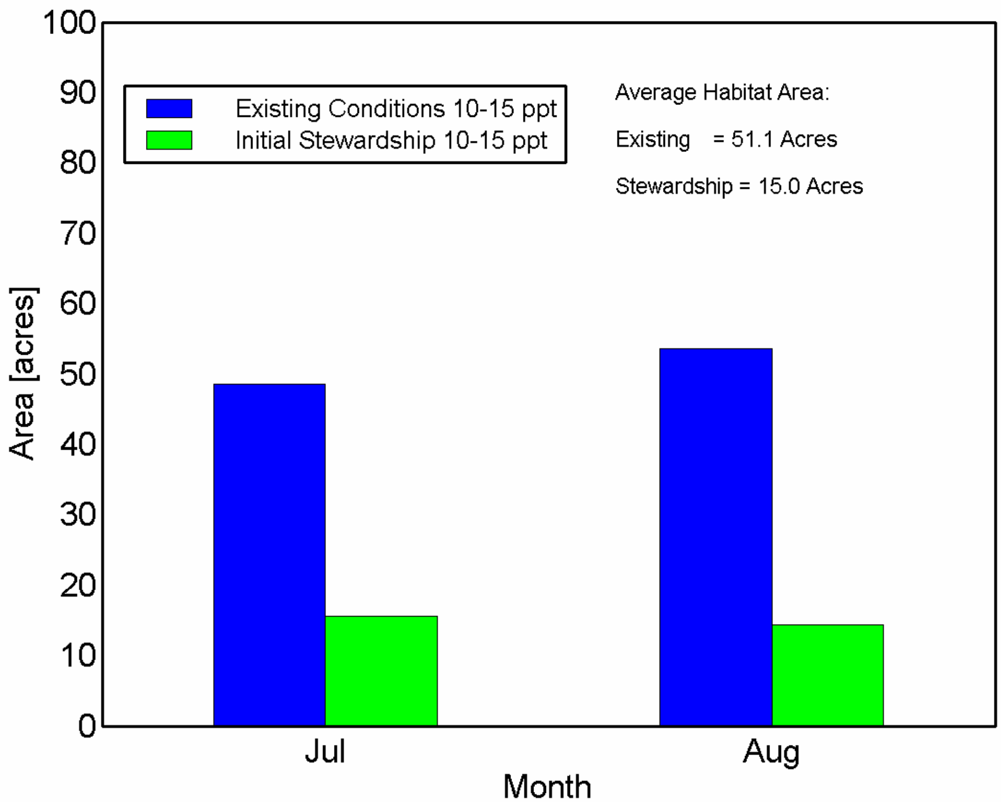
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994-1995 weather and tidal conditions.

Figure 20. Predicted juvenile bay shrimp preferred habitat area in Alviso Slough for the period July through August. Comparison between existing conditions and Initial Stewardship conditions assuming phased pond discharges commence on July 1 at proposed maximum salinities.



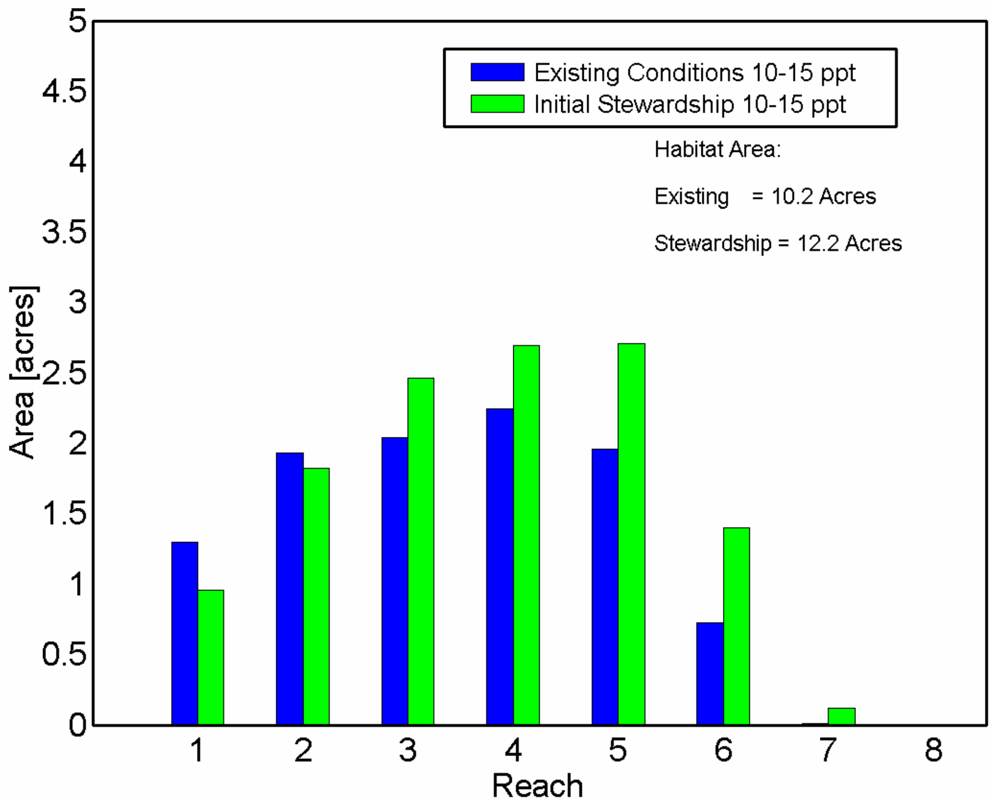
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994-1995 weather and tidal conditions.

Figure 21. Predicted juvenile bay shrimp preferred habitat area in Coyote Creek for the period July through August. Comparison between existing conditions and Initial Stewardship conditions assuming phased pond discharges commence on July 1 at proposed maximum salinities.



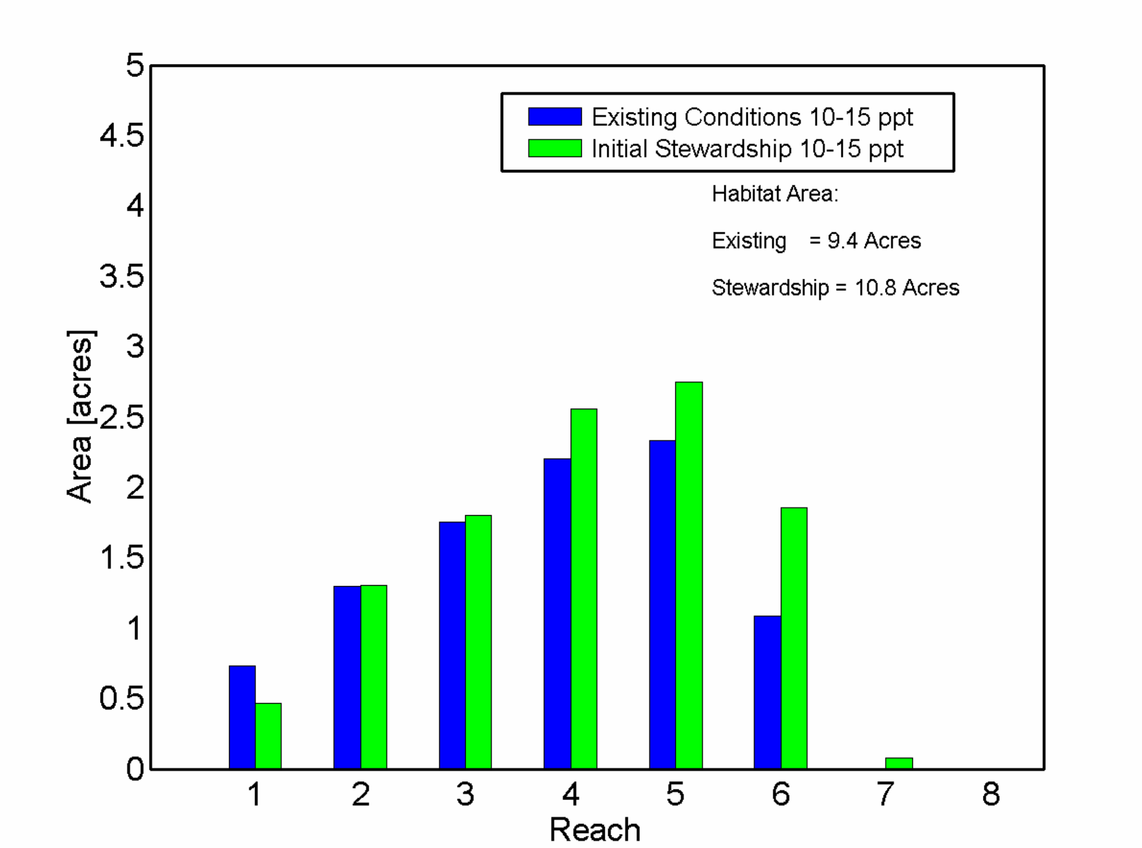
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994-1995 weather and tidal conditions.

Figure 22. Predicted juvenile bay shrimp preferred habitat area in Guadalupe Slough for the period July through August. Comparison between existing conditions and Initial Stewardship conditions assuming phased pond discharges commence on July 1 at proposed maximum salinities.



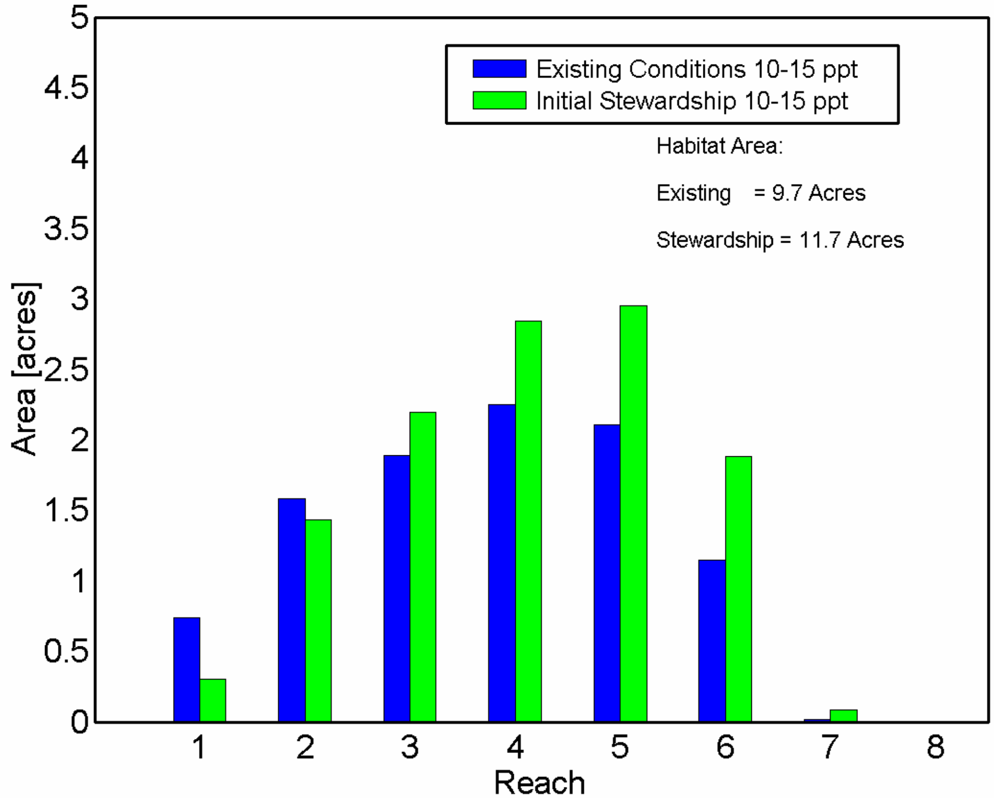
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix A, Figure 1. Predicted juvenile bay shrimp preferred habitat area in the Alameda Flood Control Channel in May, the second month of the Initial Release Period. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



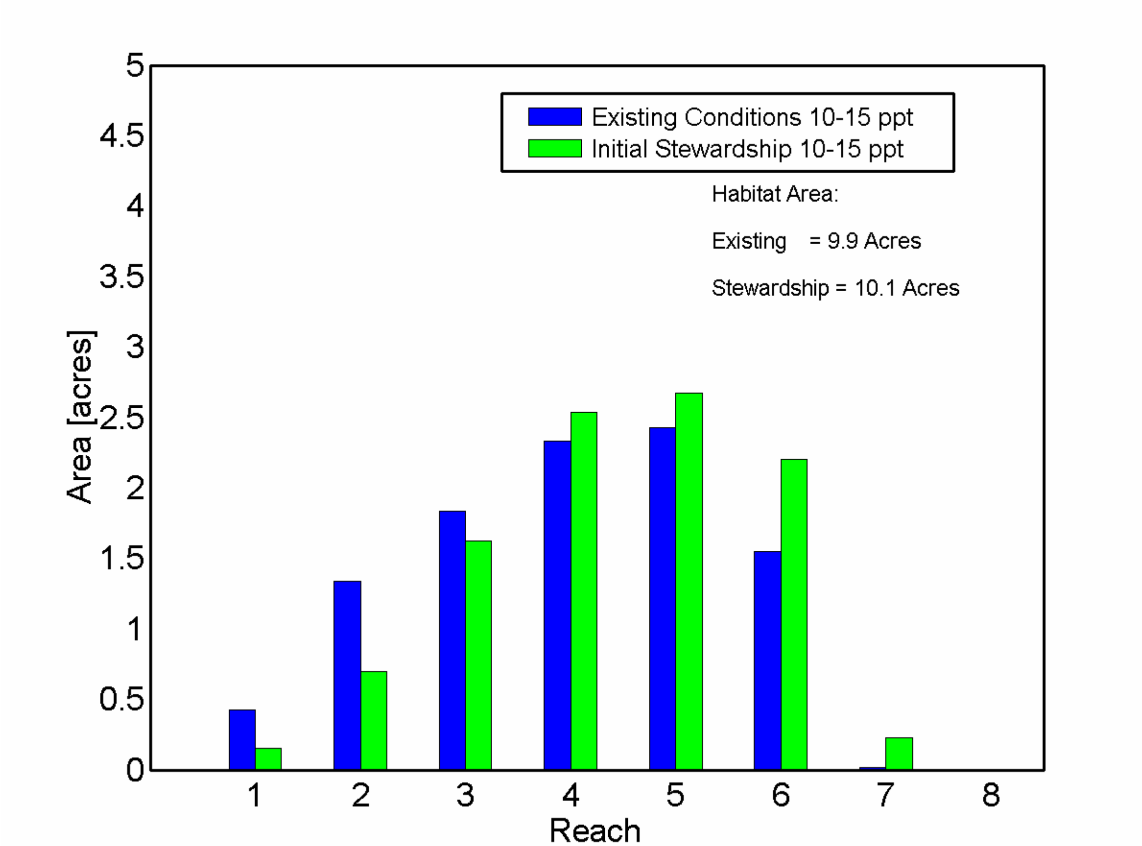
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix A, Figure 2. Predicted juvenile bay shrimp preferred habitat area in the Alameda Flood Control Channel in June. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



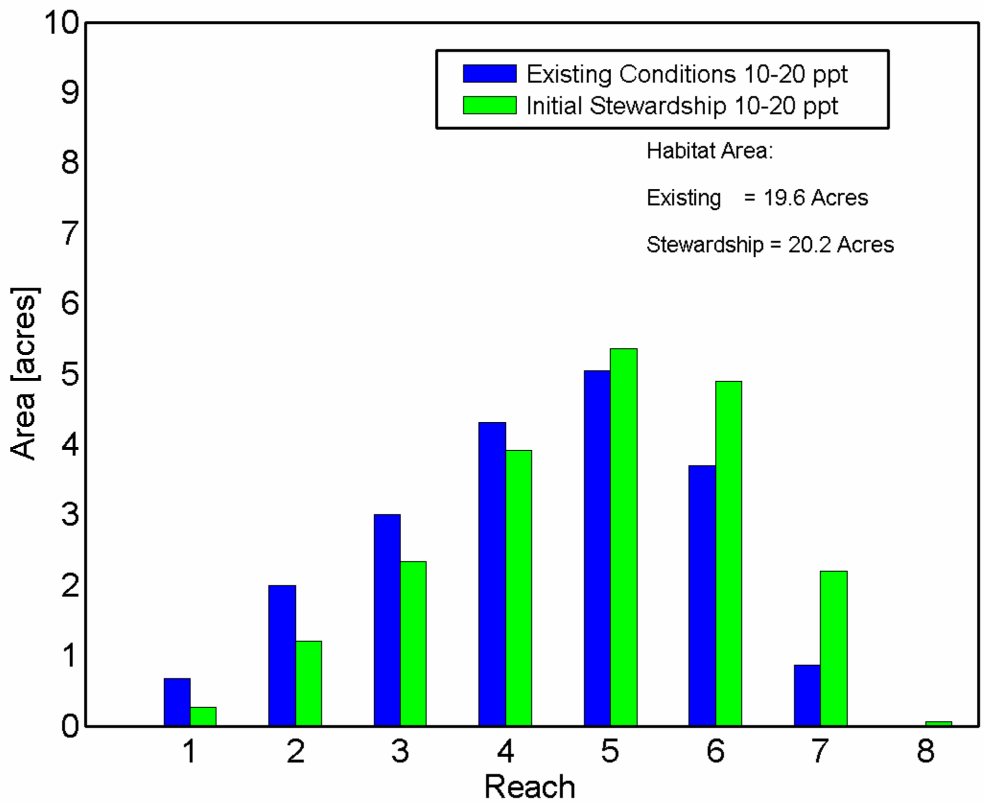
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix A, Figure 3. Predicted juvenile bay shrimp preferred habitat area in the Alameda Flood Control Channel in July. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



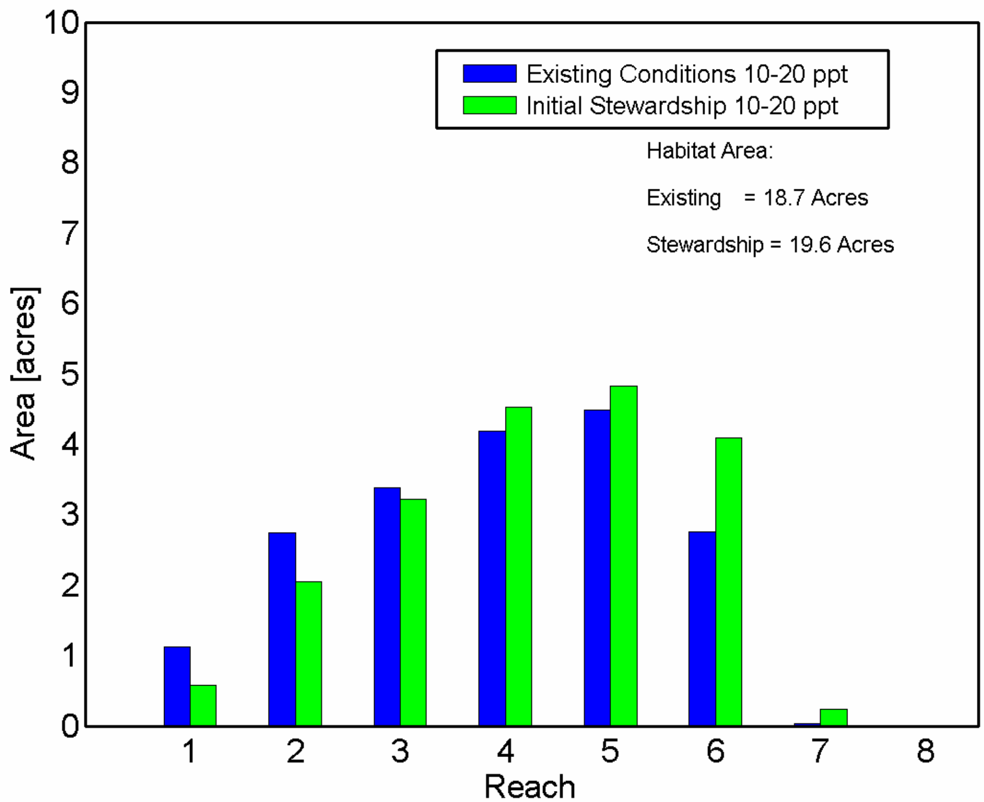
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix A, Figure 4. Predicted juvenile bay shrimp preferred habitat area in the Alameda Flood Control Channel in August. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



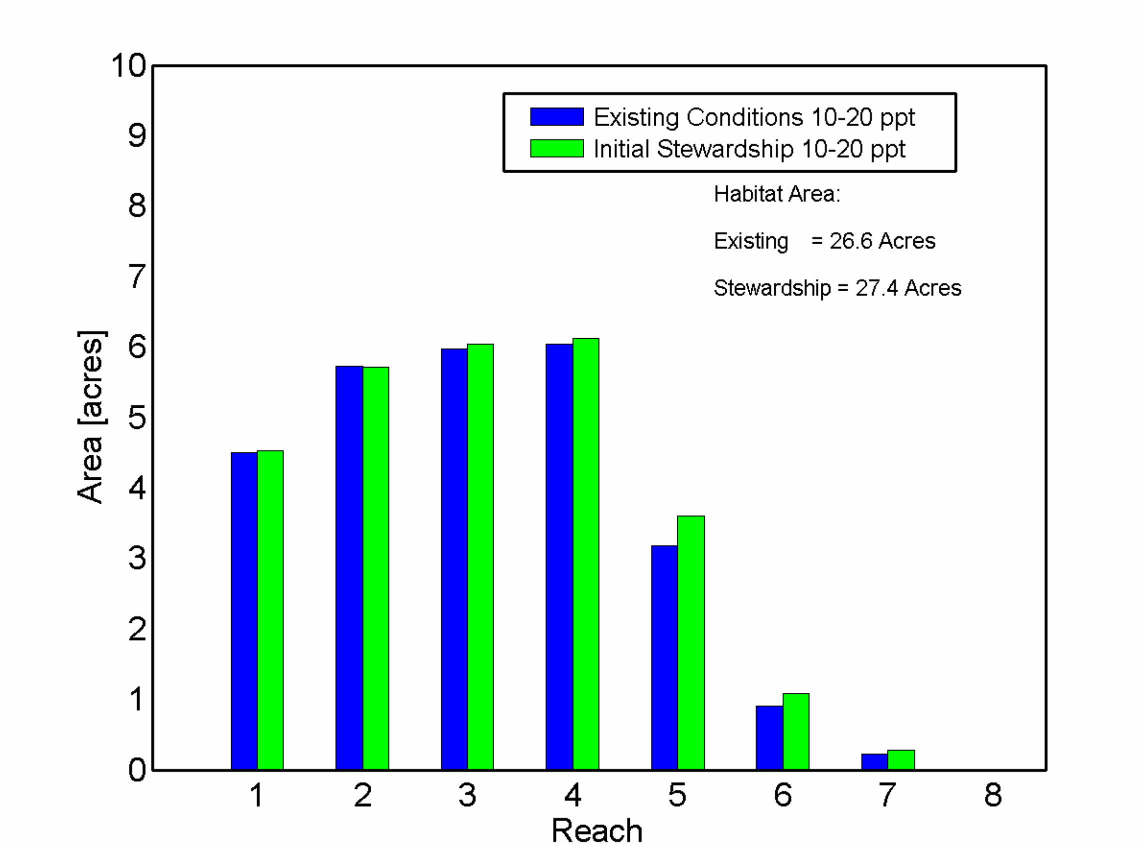
Note: Adult bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 20 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix A, Figure 5. Predicted adult bay shrimp preferred habitat area in the Alameda Flood Control Channel in September. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



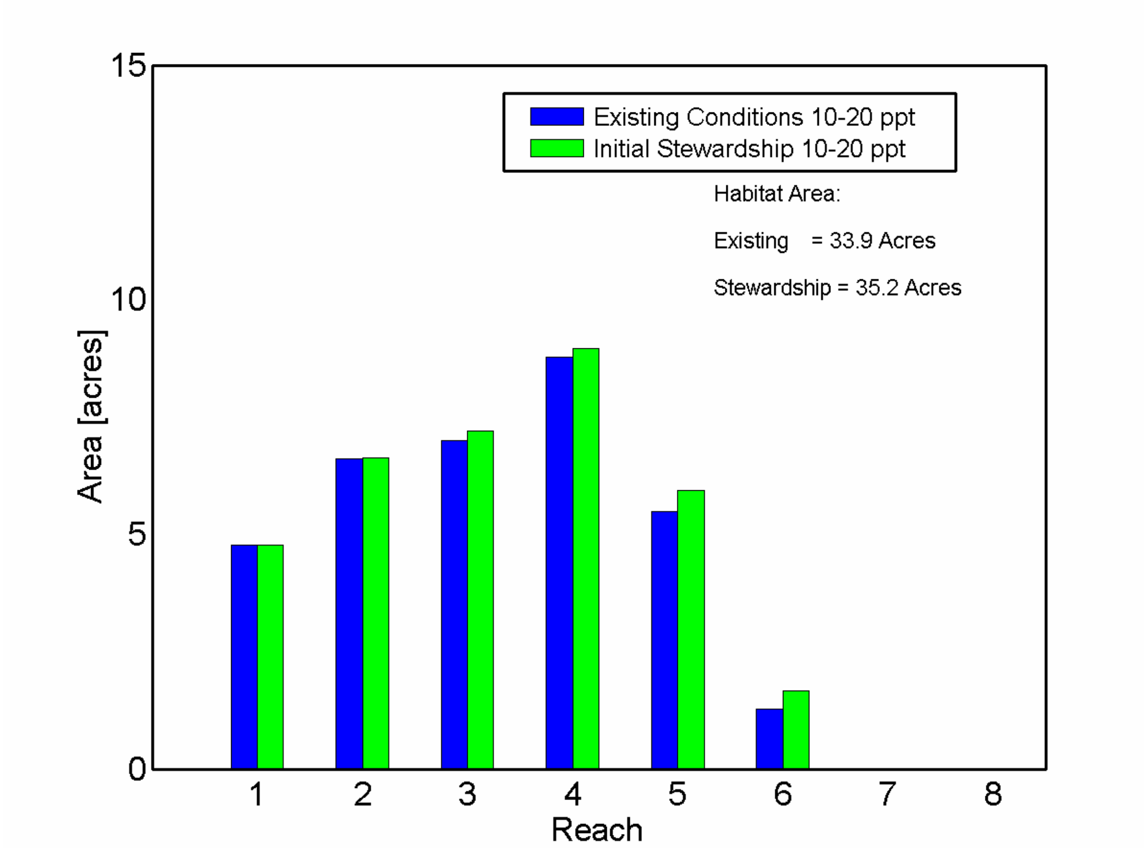
Note: Adult bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 20 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix A, Figure 6. Predicted adult bay shrimp preferred habitat area in the Alameda Flood Control Channel in October. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



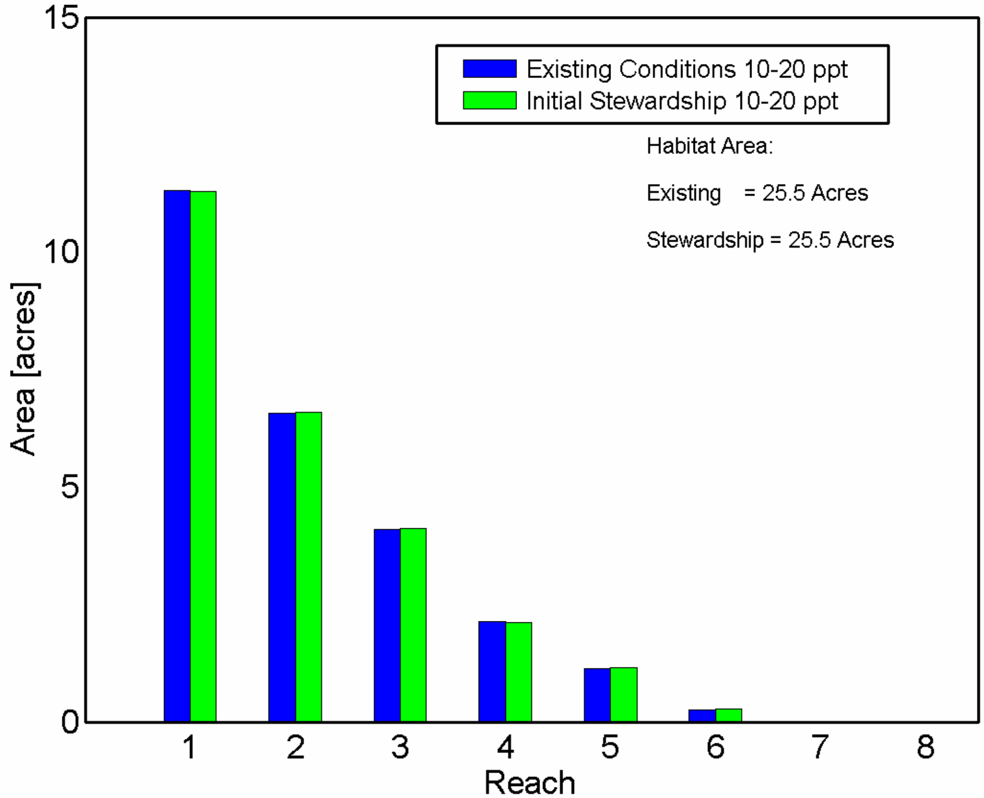
Note: Adult bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 20 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix A, Figure 7. Predicted adult bay shrimp preferred habitat area in the Alameda Flood Control Channel in November. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



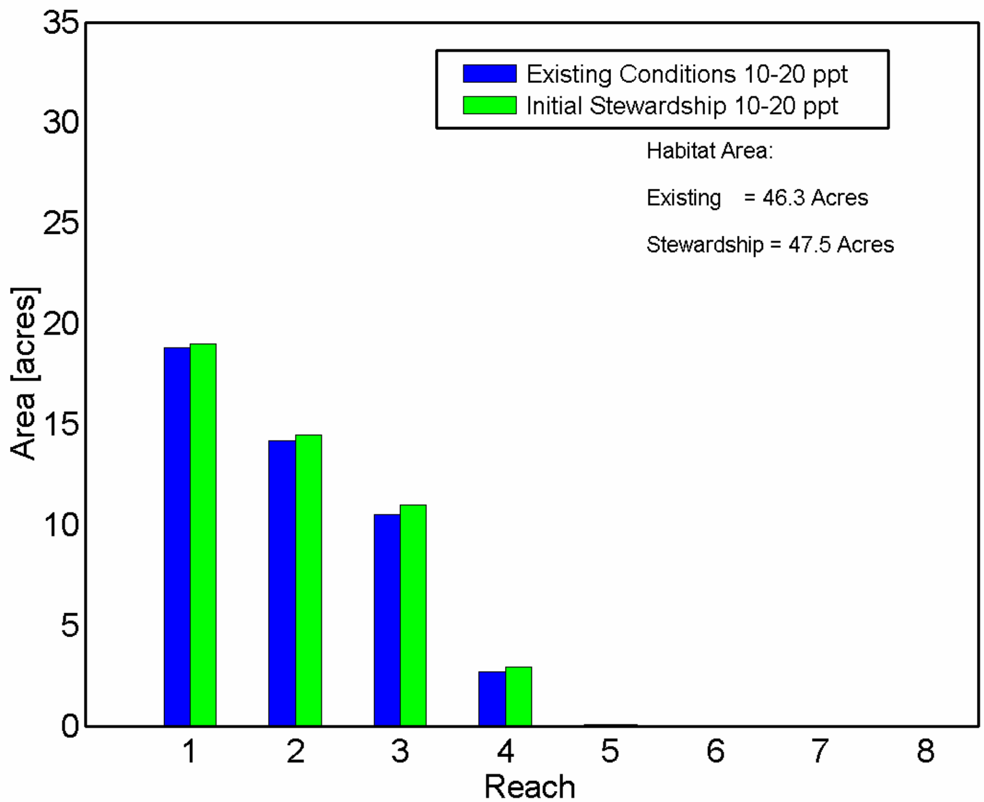
Note: Adult bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 20 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix A, Figure 8. Predicted adult bay shrimp preferred habitat area in the Alameda Flood Control Channel in December. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



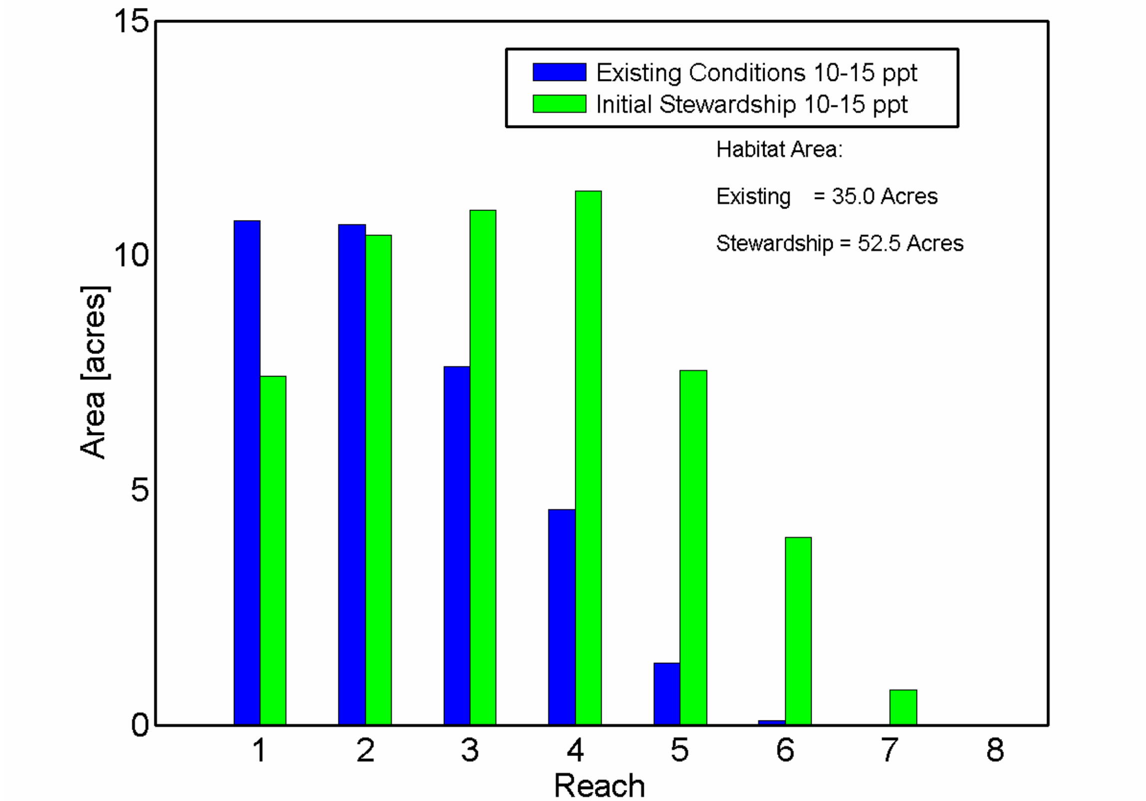
Note: Adult bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 20 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix A, Figure 9. Predicted adult bay shrimp preferred habitat area in the Alameda Flood Control Channel in January. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



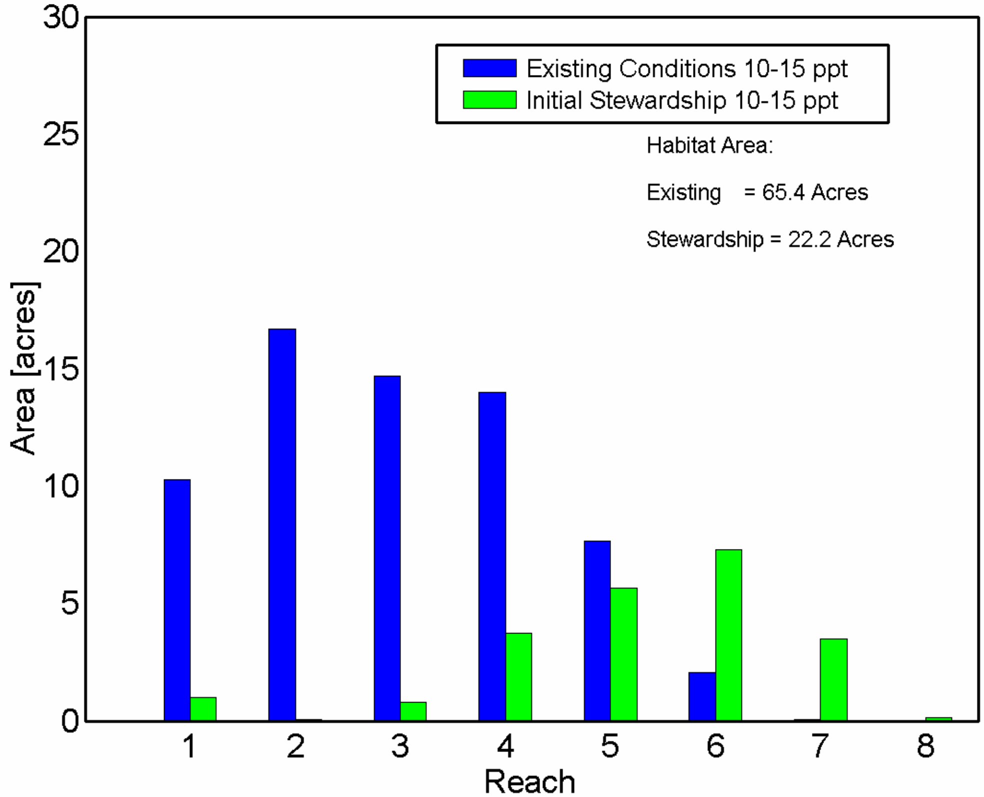
Note: Adult bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 20 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix A, Figure 10. Predicted adult bay shrimp preferred habitat area in the Alameda Flood Control Channel in February. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



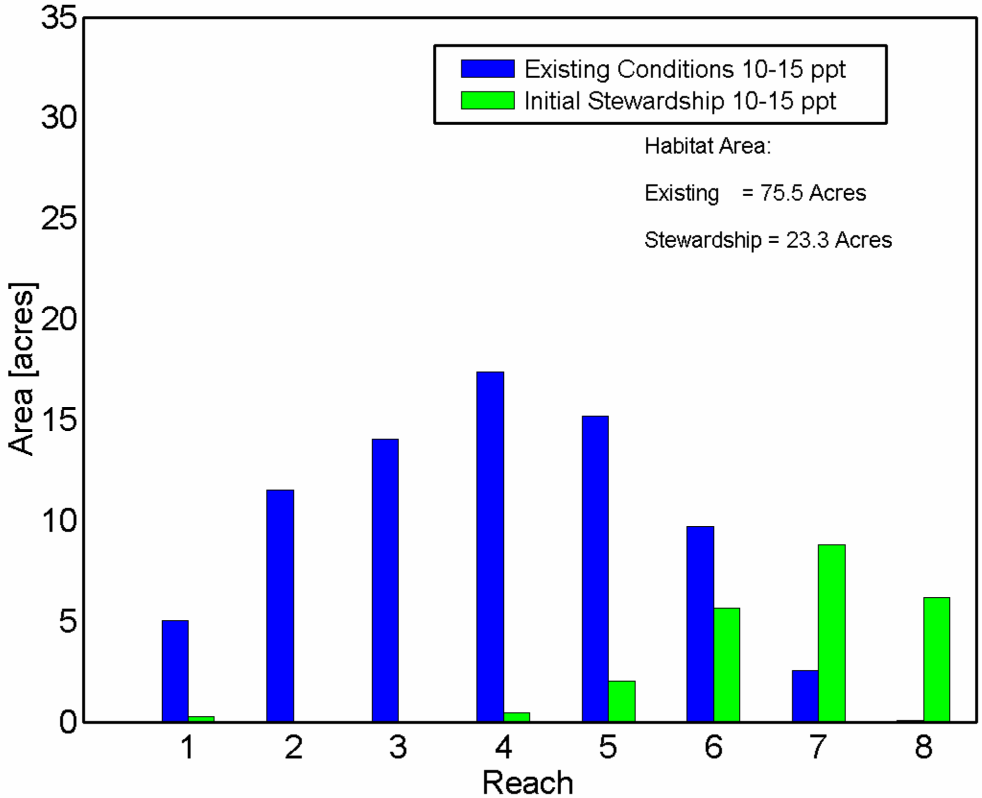
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix B, Figure 1. Predicted juvenile bay shrimp preferred habitat area in Alviso Slough in May, the second month of the Initial Release Period. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



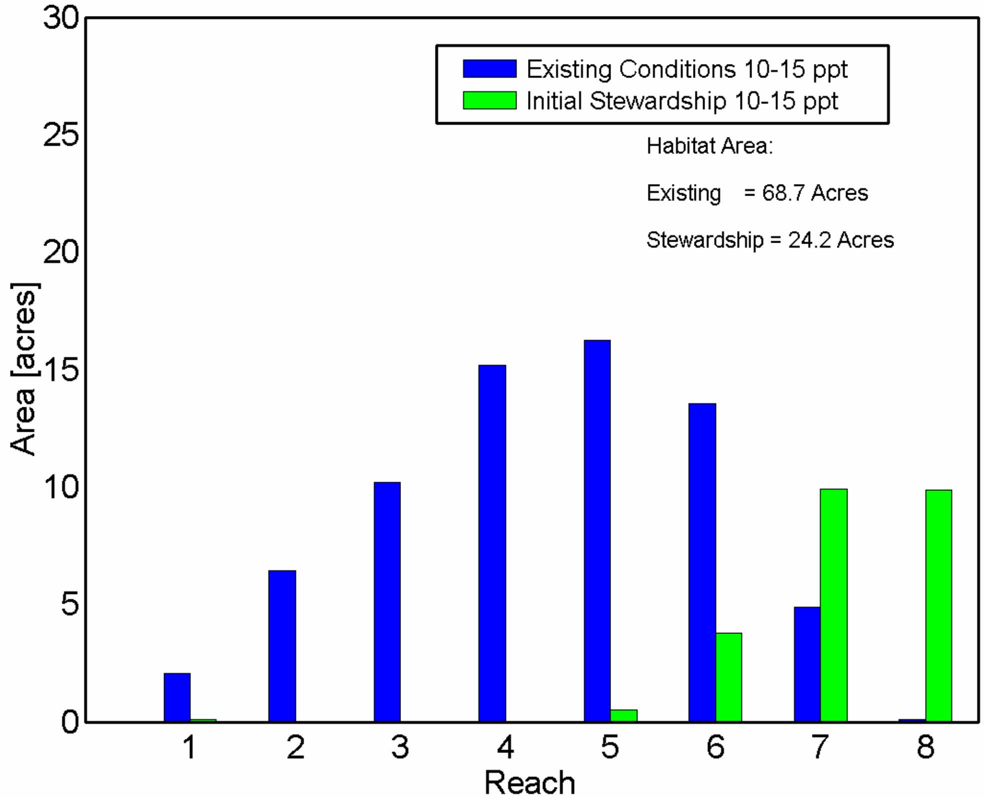
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix B, Figure 2. Predicted juvenile bay shrimp preferred habitat area in Alviso Slough in June. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



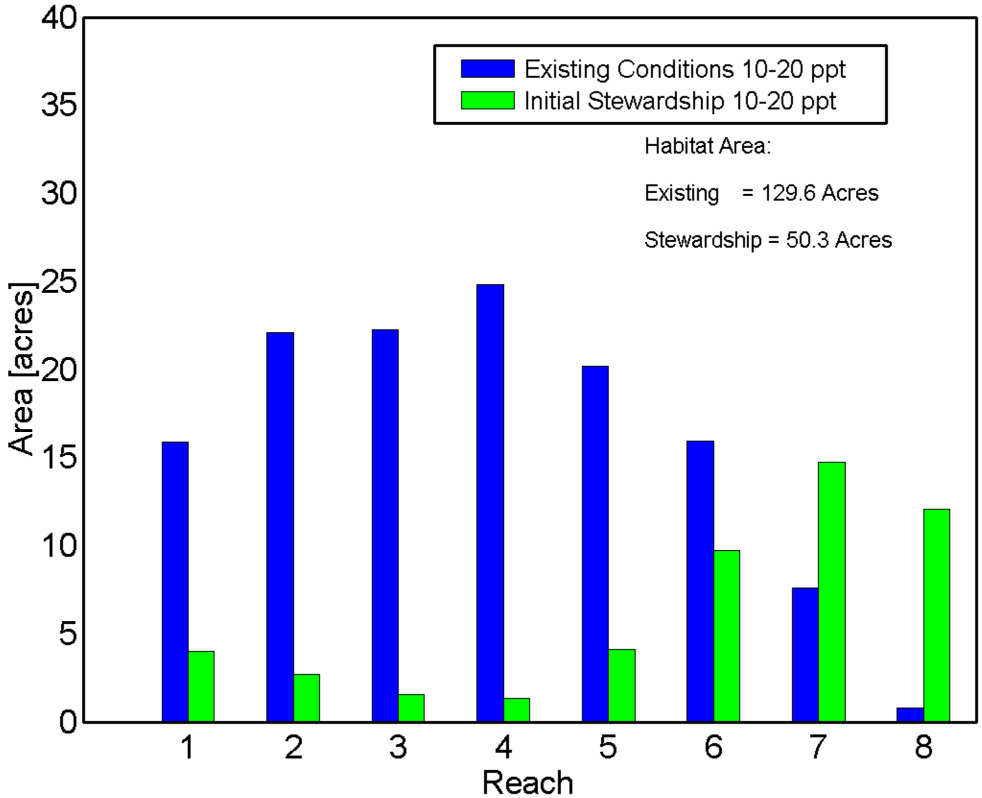
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix B, Figure 3. Predicted juvenile bay shrimp preferred habitat area in Alviso Slough in July. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



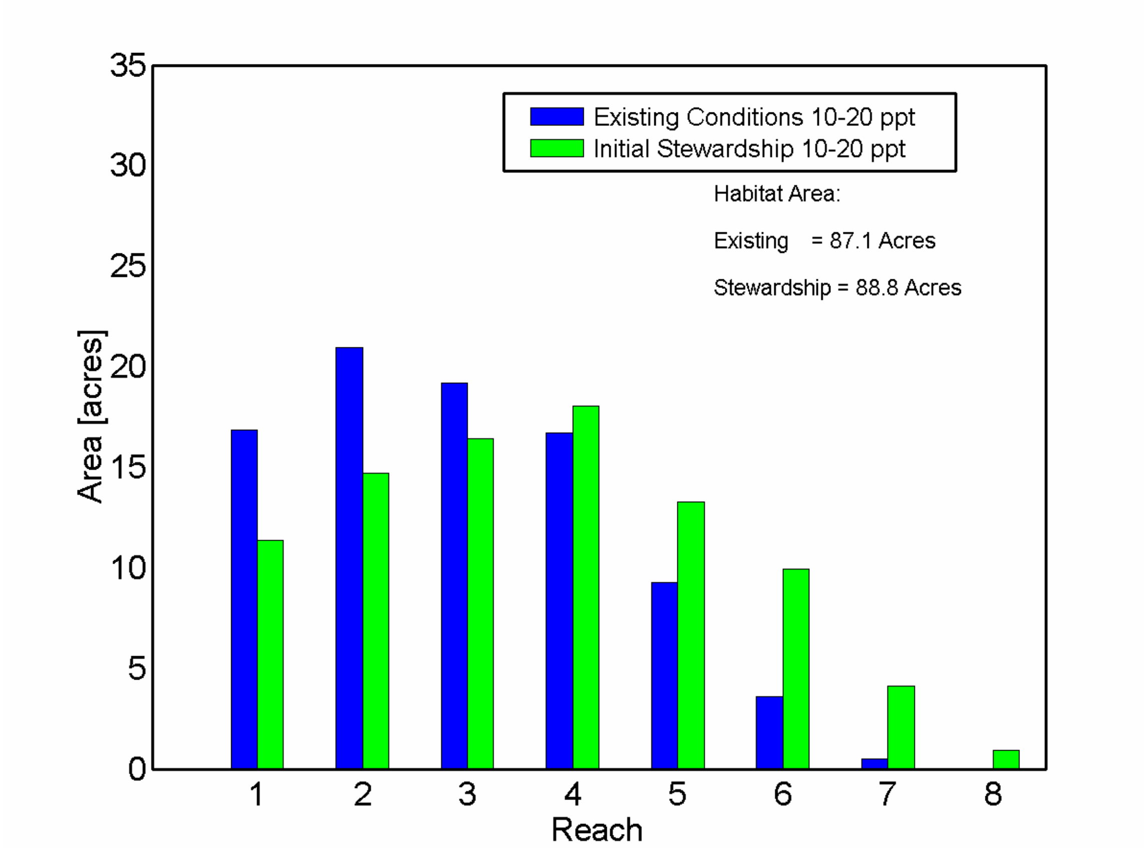
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix B, Figure 4. Predicted juvenile bay shrimp preferred habitat area in Alviso Slough in August. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



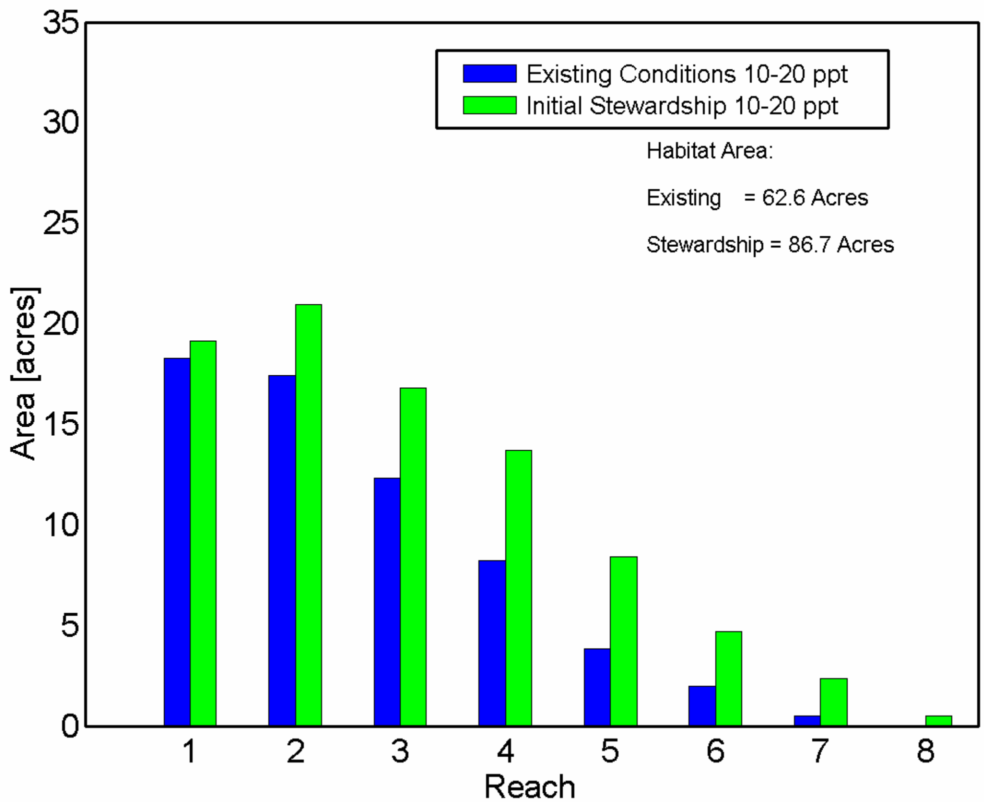
Note: Adult bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 20 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix B, Figure 5. Predicted adult bay shrimp preferred habitat area in Alviso Slough in September. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



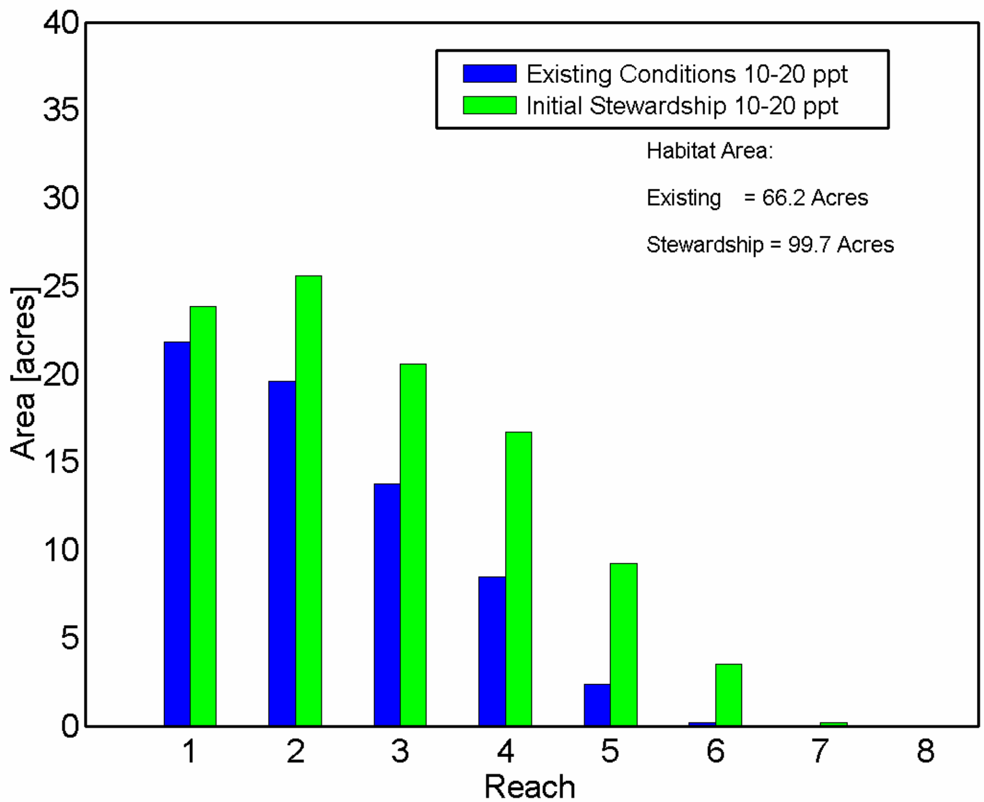
Note: Adult bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 20 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix B, Figure 6. Predicted adult bay shrimp preferred habitat area in Alviso Slough in October. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



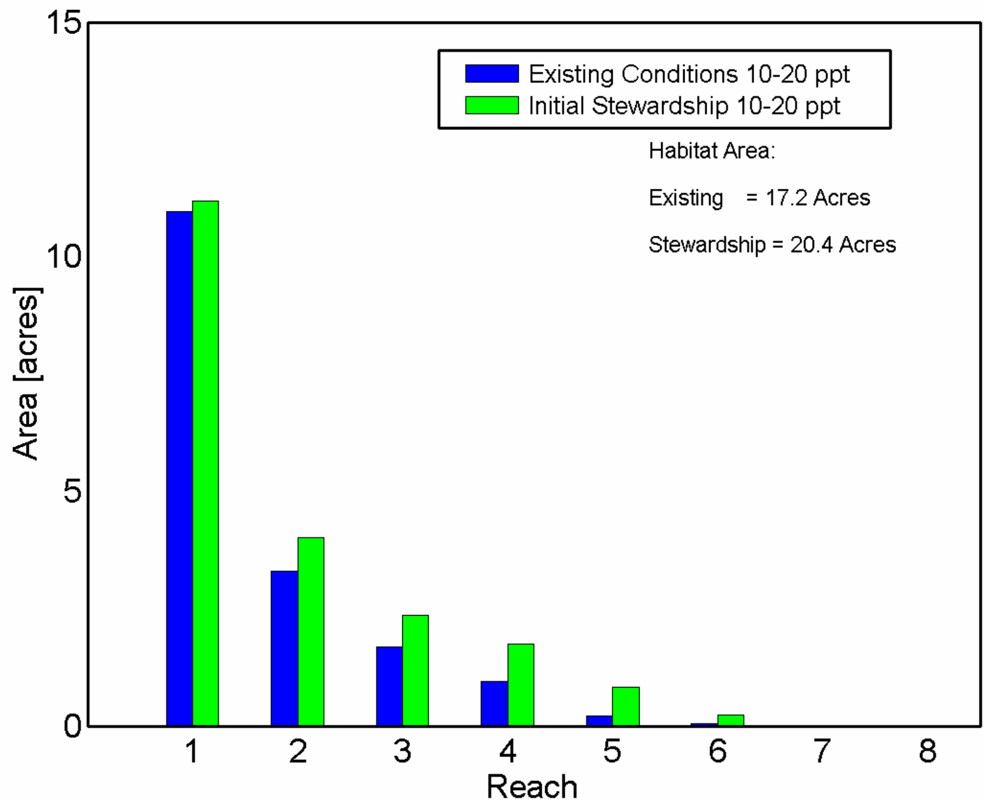
Note: Adult bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 20 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix B, Figure 7. Predicted adult bay shrimp preferred habitat area in Alviso Slough in November. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



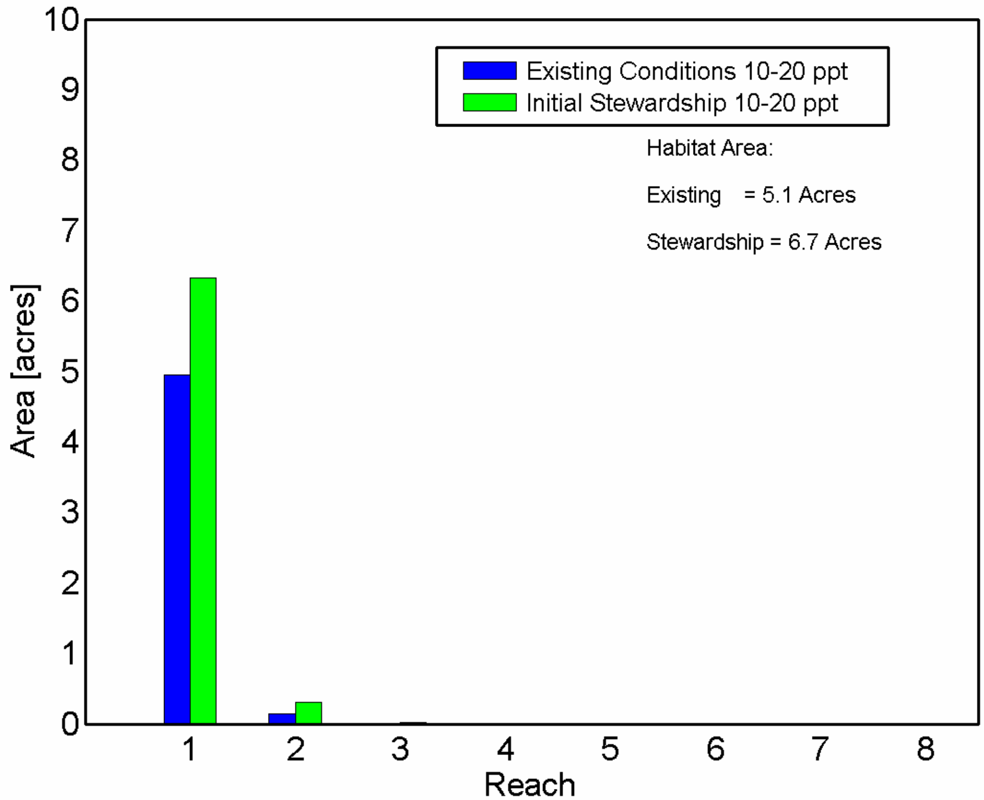
Note: Adult bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 20 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix B, Figure 8. Predicted adult bay shrimp preferred habitat area in Alviso Slough in December. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



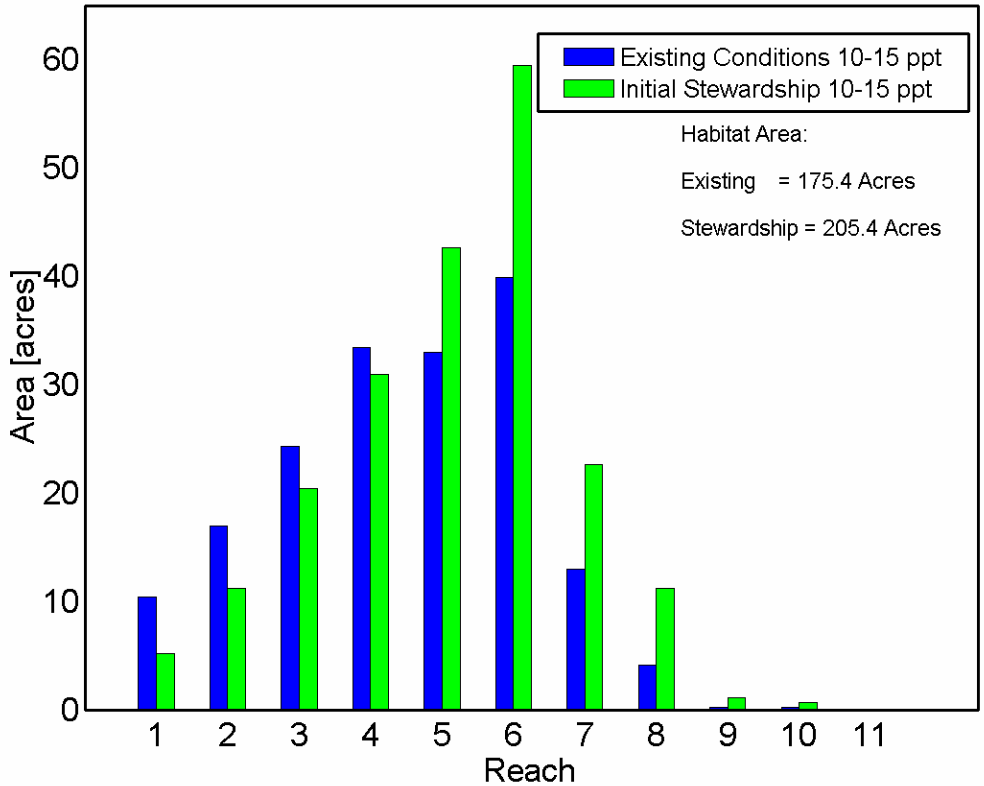
Note: Adult bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 20 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix B, Figure 9. Predicted adult bay shrimp preferred habitat area in Alviso Slough in January. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



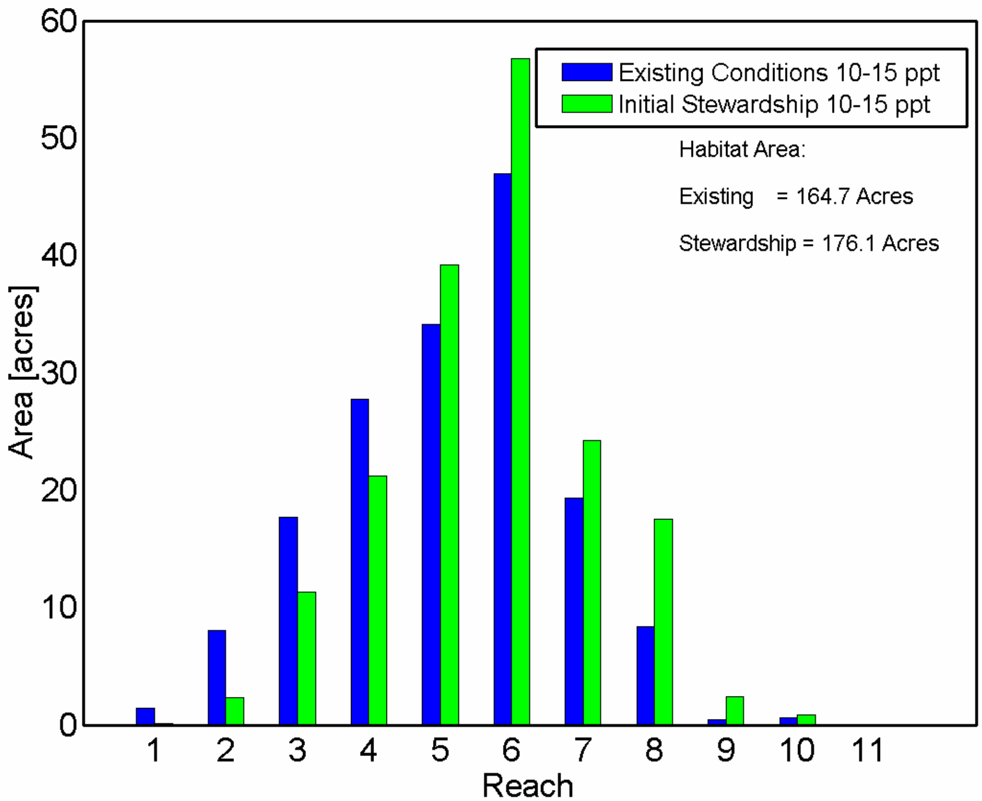
Note: Adult bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 20 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix B, Figure 10. Predicted adult bay shrimp preferred habitat area in Alviso Slough in February. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



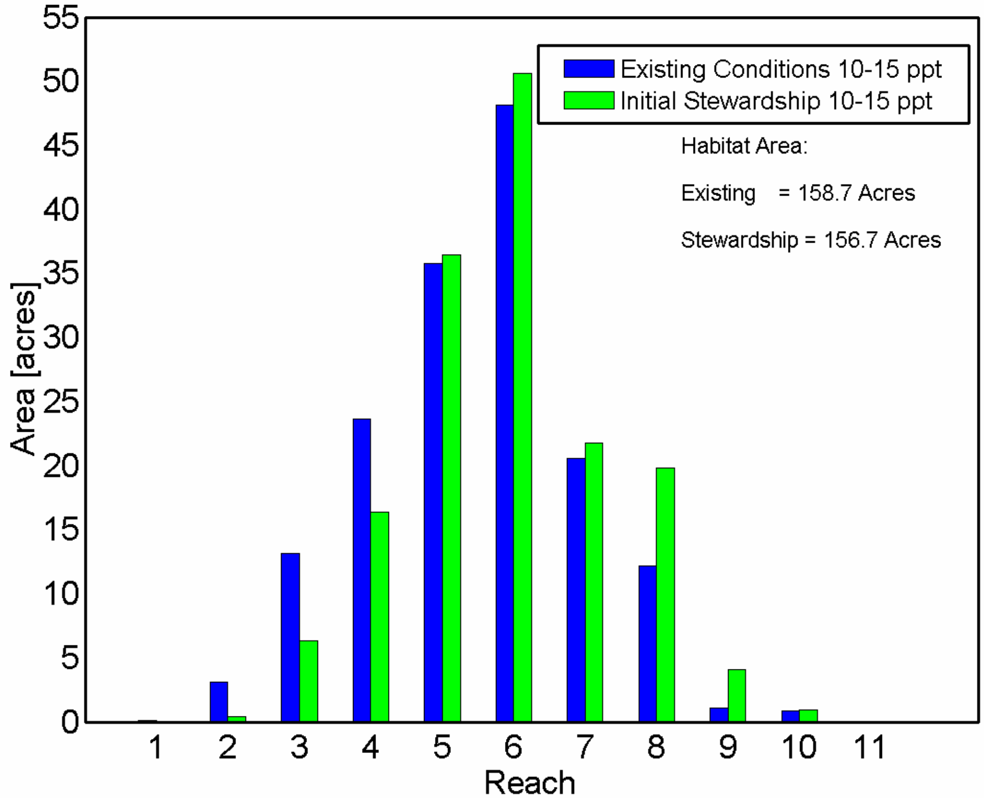
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix C, Figure 1. Predicted juvenile bay shrimp preferred habitat area in Coyote Creek in May, the second month of the Initial Release Period. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



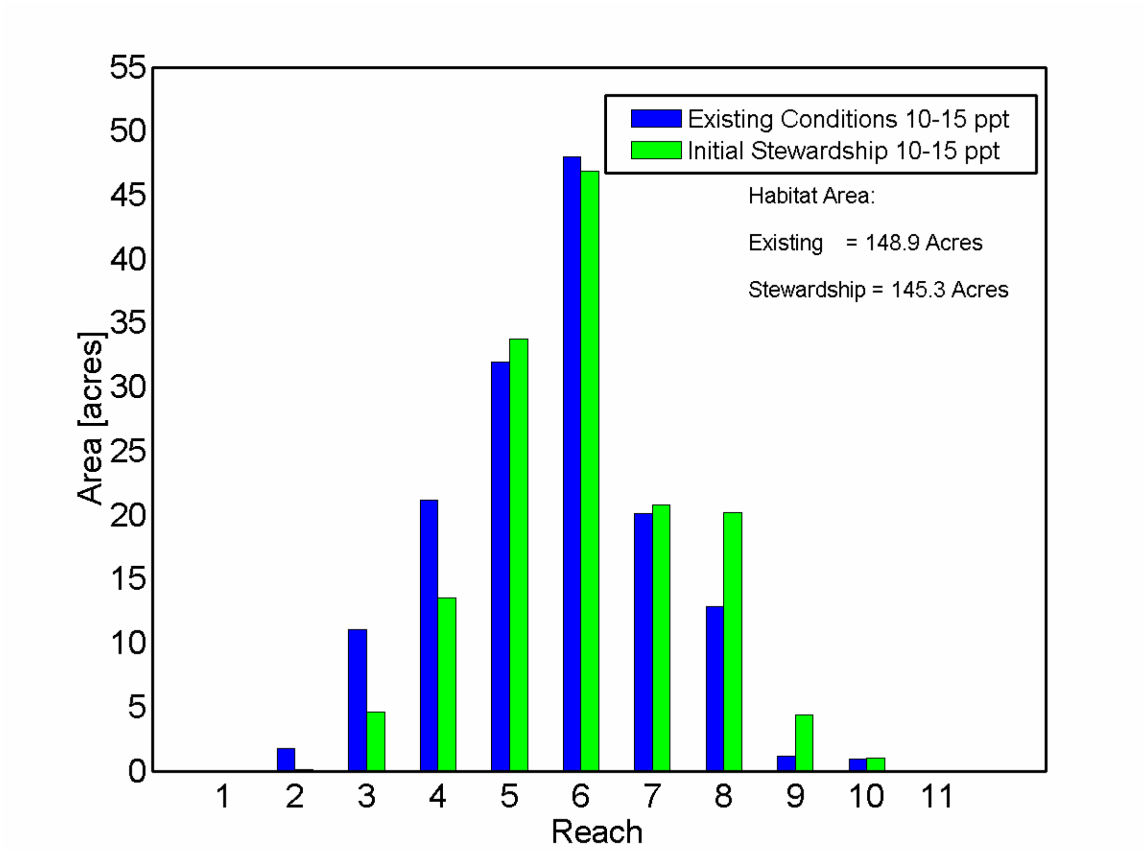
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix C, Figure 2. Predicted juvenile bay shrimp preferred habitat area in Coyote Creek in June. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



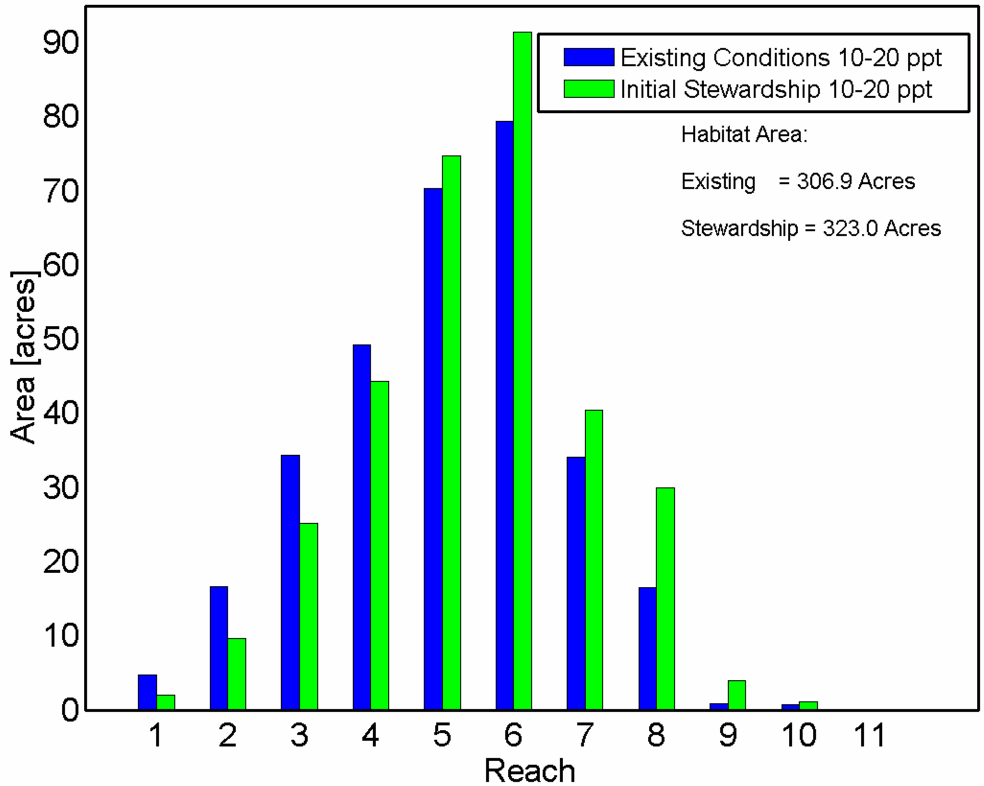
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix C, Figure 3. Predicted juvenile bay shrimp preferred habitat area in Coyote Creek in July. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



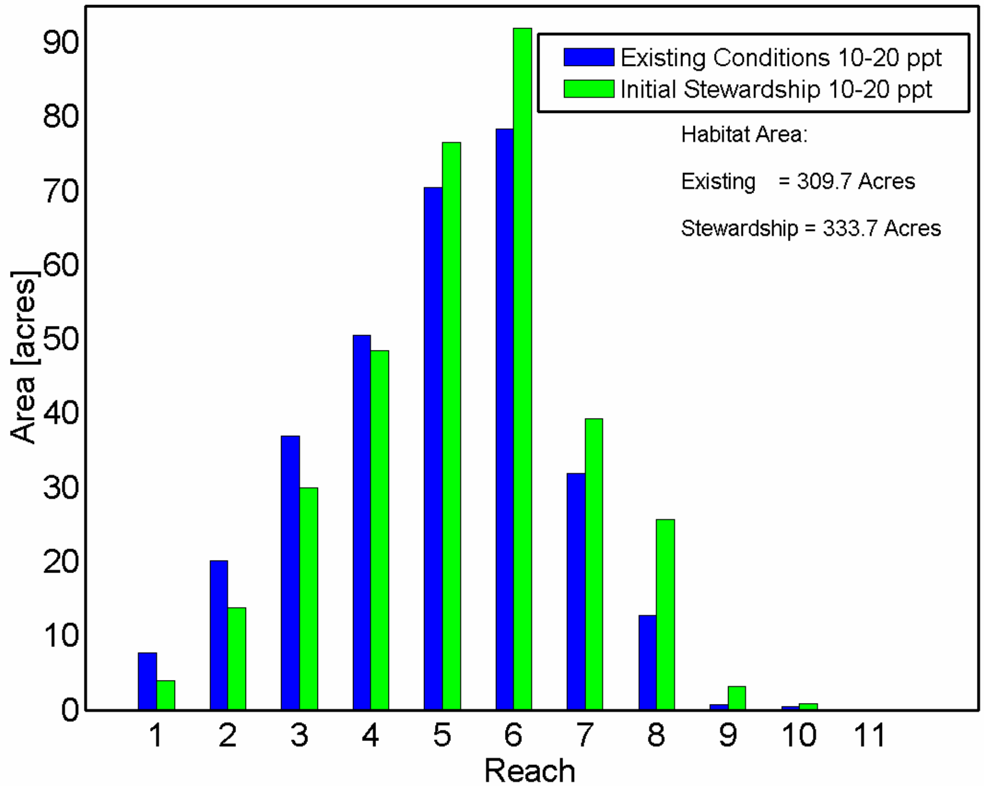
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix C, Figure 4. Predicted juvenile bay shrimp preferred habitat area in Coyote Creek in August. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



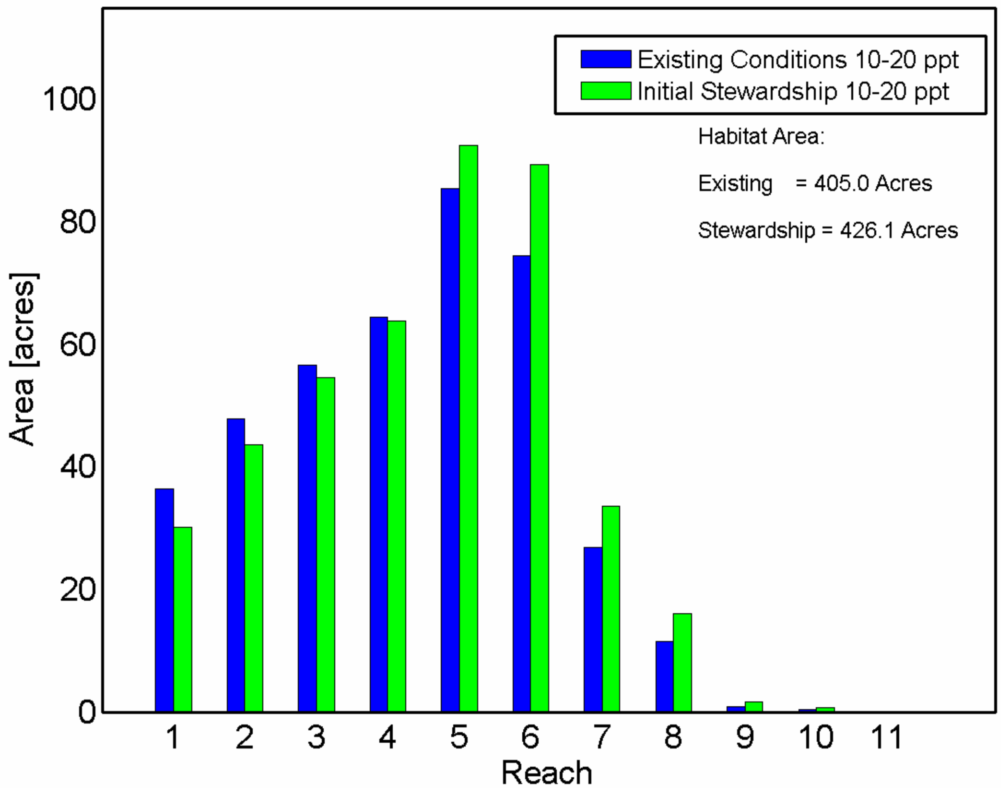
Note: Adult bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 20 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix C, Figure 5. Predicted adult bay shrimp preferred habitat area in Coyote Creek in September. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



Note: Adult bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 20 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix C, Figure 6. Predicted adult bay shrimp preferred habitat area in Coyote Creek in October. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



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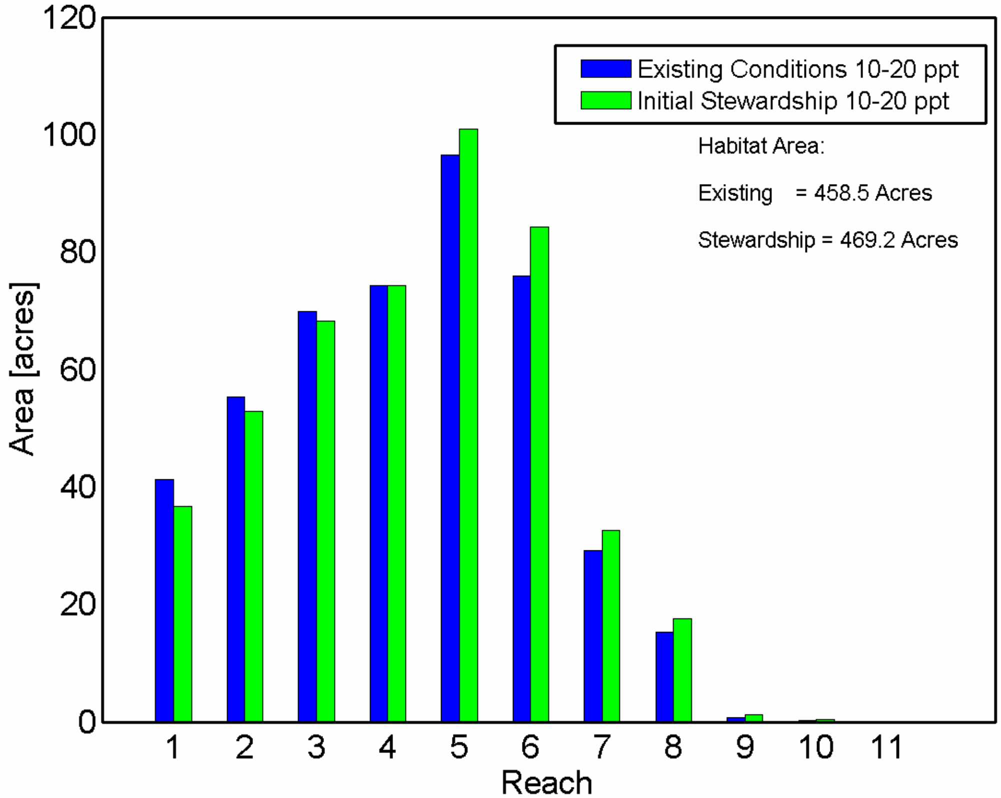

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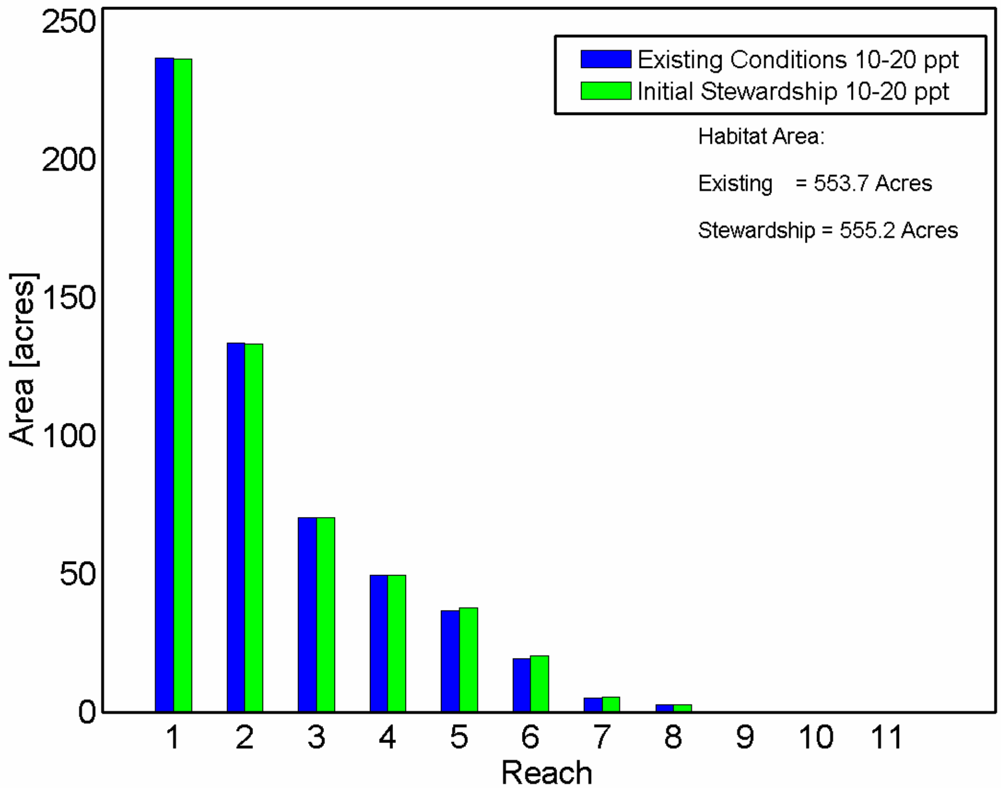
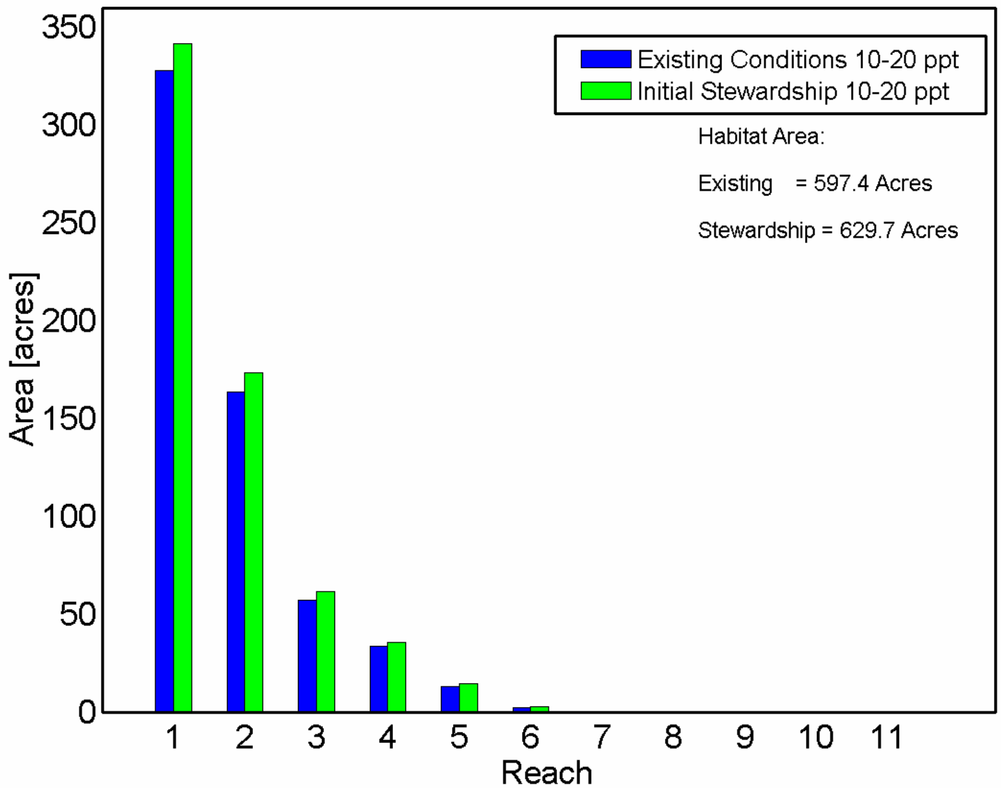


Note: Adult bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 20 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix C, Figure 9. Predicted adult bay shrimp preferred habitat area in Coyote Creek in January. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



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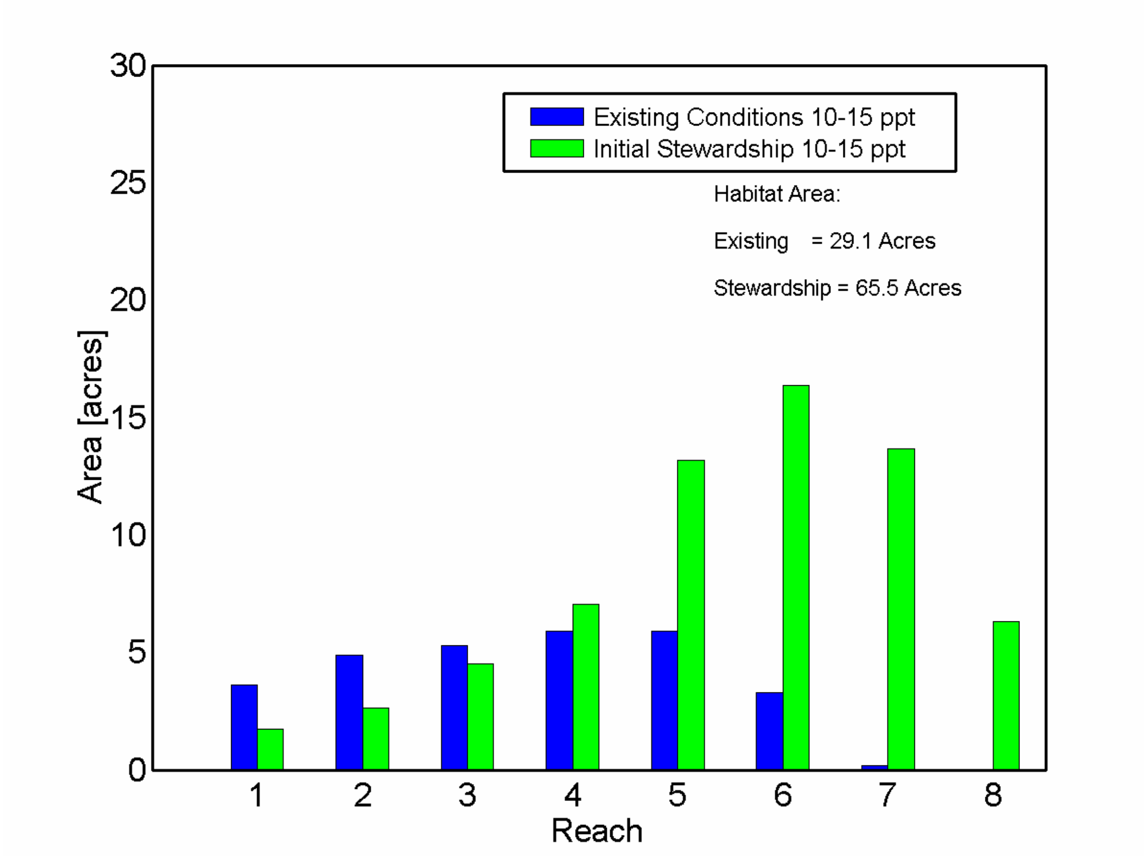
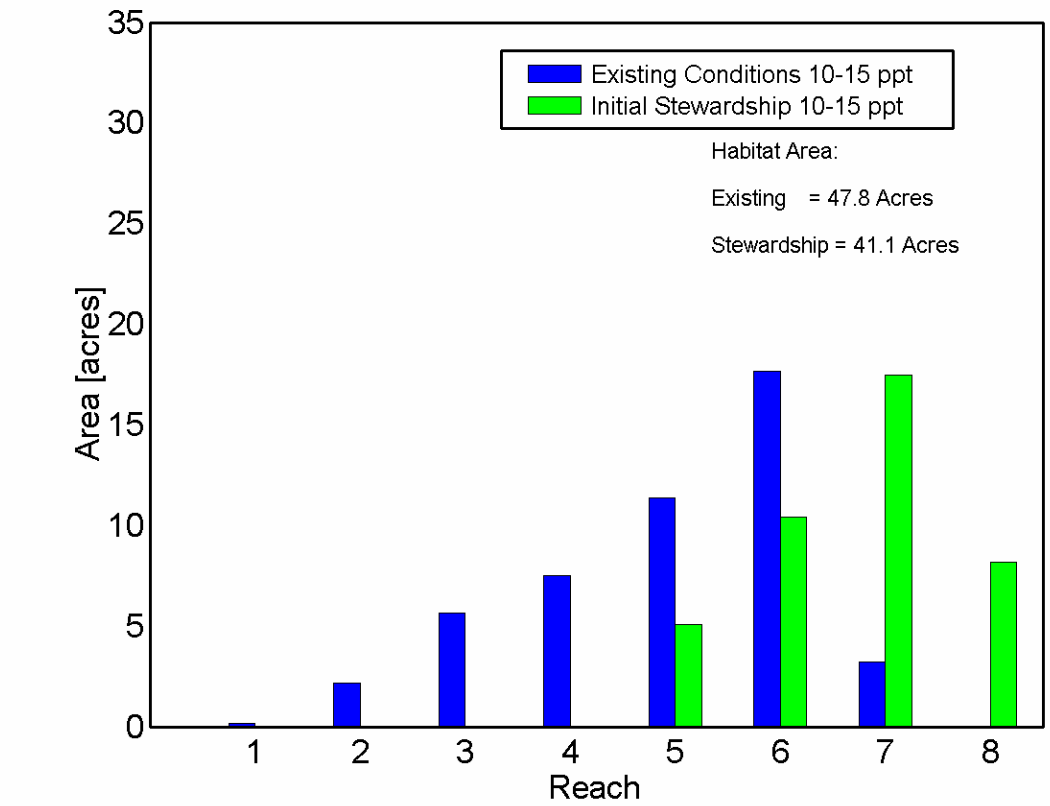
Appendix C, Figure 10. Predicted adult bay shrimp preferred habitat area in Coyote Creek in February. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



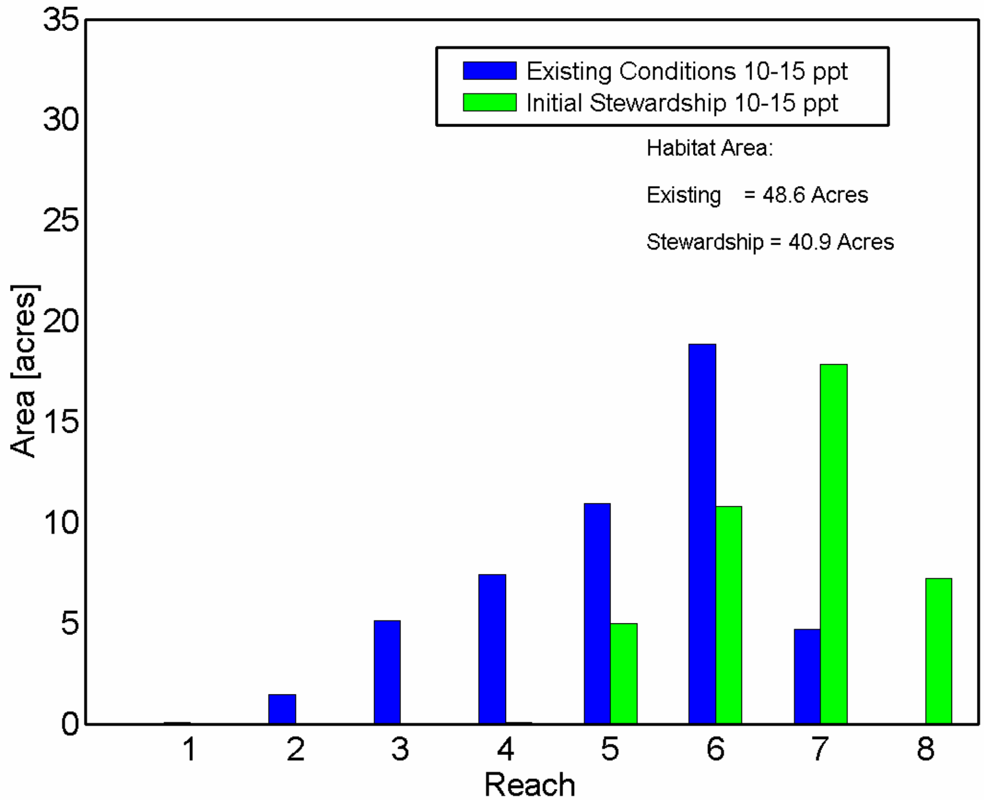
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994-1995 weather and tidal conditions.

Appendix D, Figure 1. Predicted juvenile bay shrimp preferred habitat area in Guadalupe Slough in May, the second month of the Initial Release Period. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



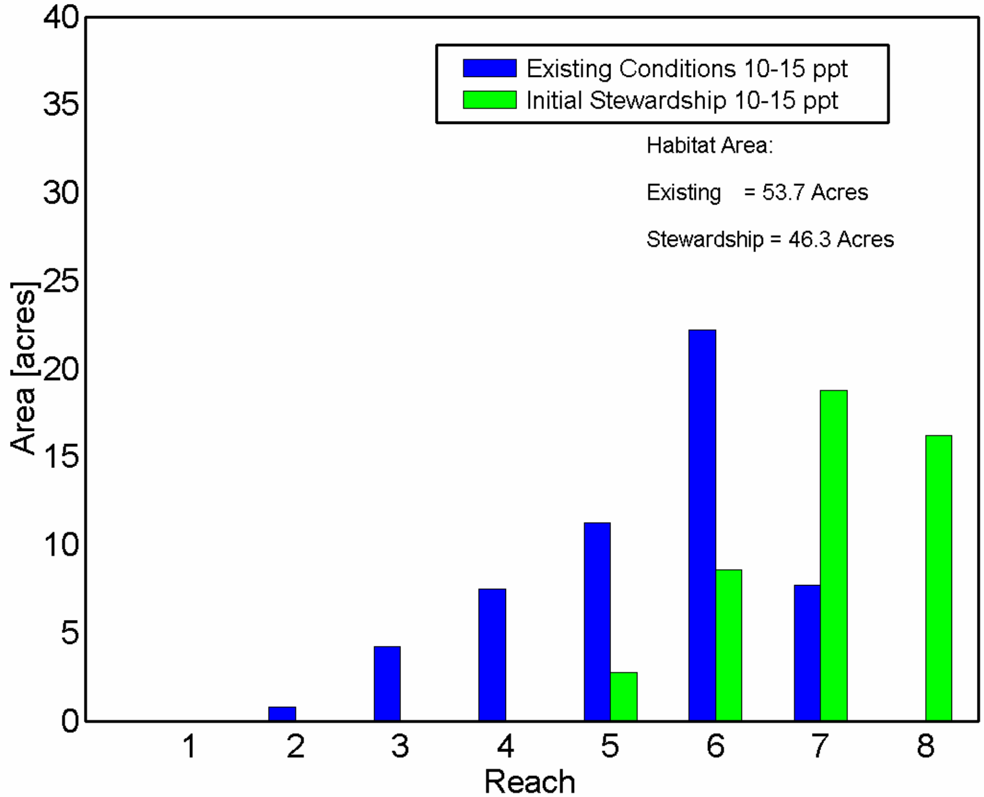
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix D, Figure 2. Predicted juvenile bay shrimp preferred habitat area in Guadalupe Slough in June. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



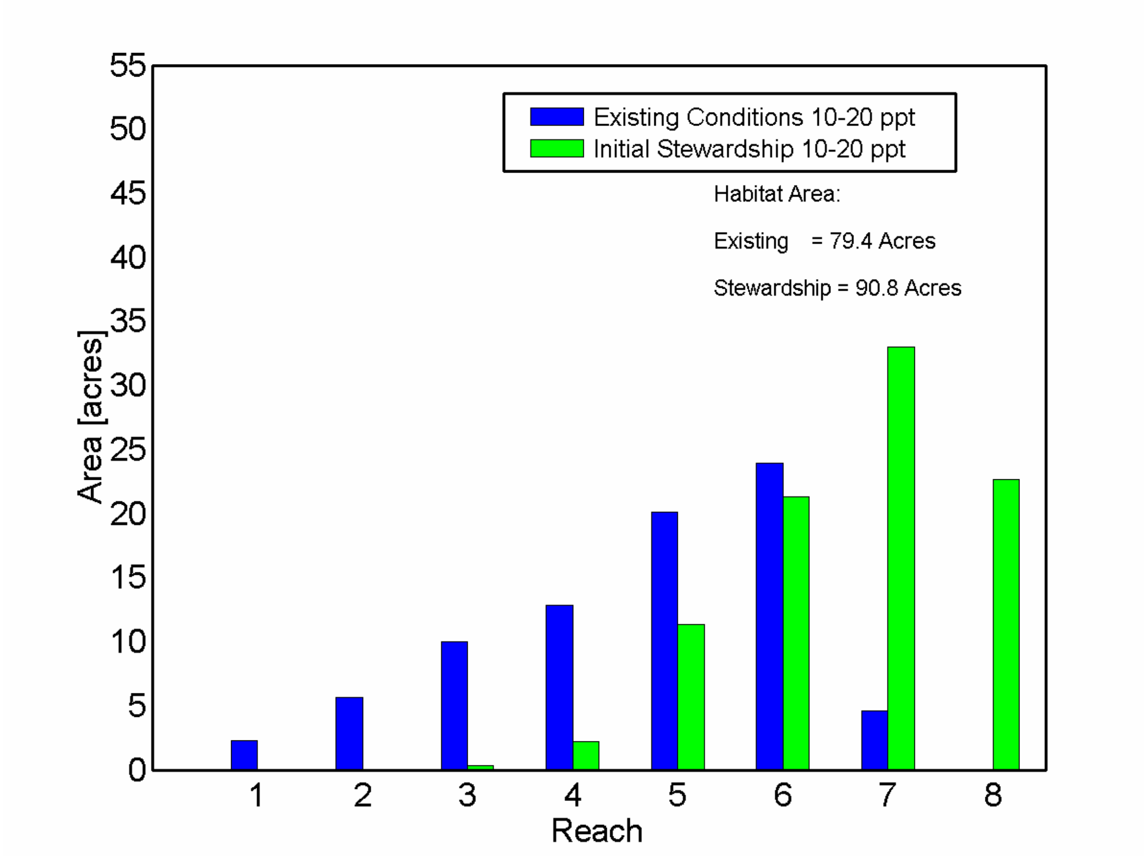
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix D, Figure 3. Predicted juvenile bay shrimp preferred habitat area in Guadalupe Slough in July. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



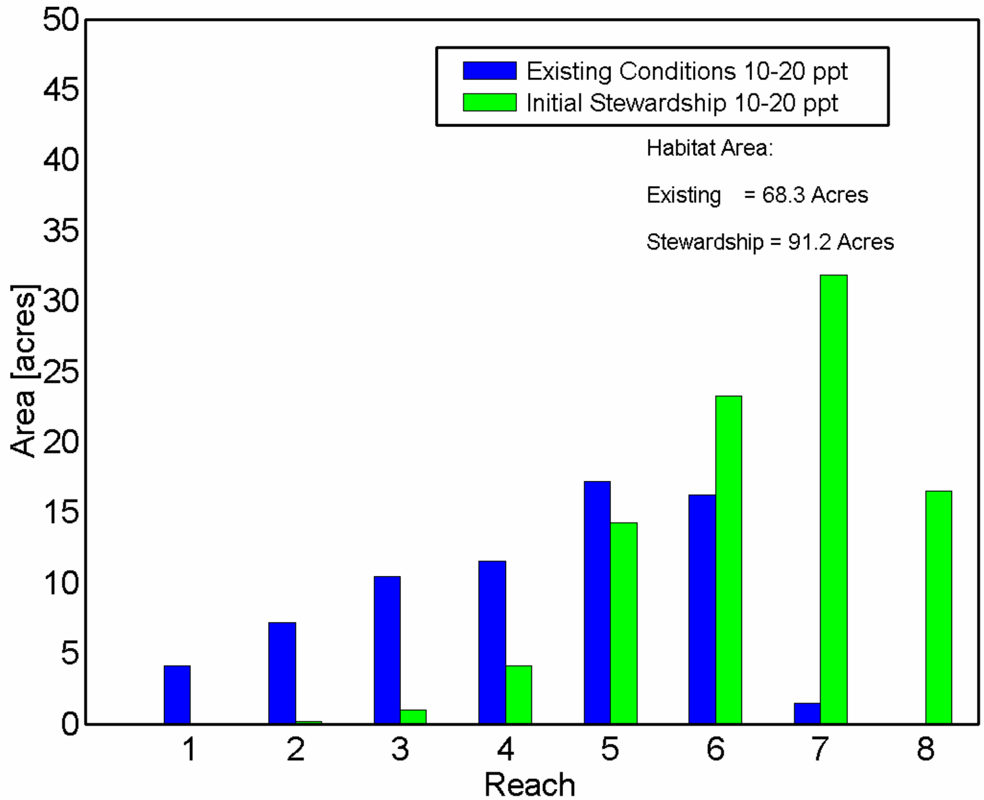
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix D, Figure 4. Predicted juvenile bay shrimp preferred habitat area in Guadalupe Slough in August. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



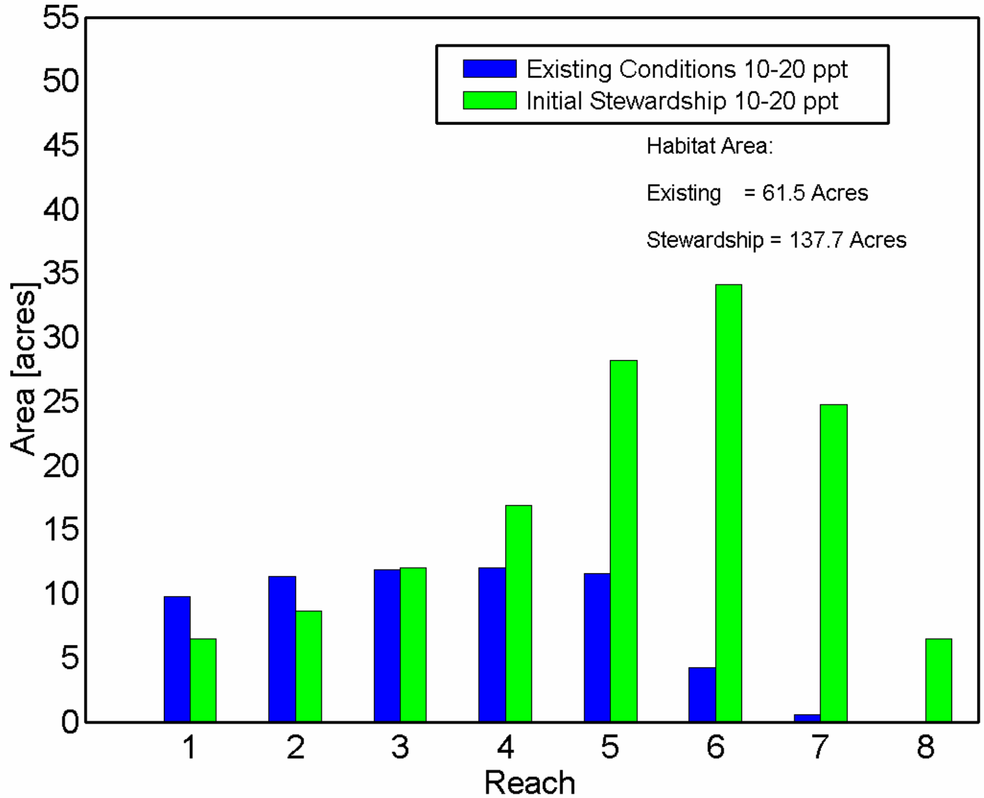
Note: Adult bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 20 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix D, Figure 5. Predicted adult bay shrimp preferred habitat area in Guadalupe Slough in September. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



Note: Adult bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 20 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix D, Figure 6. Predicted adult bay shrimp preferred habitat area in Guadalupe Slough in October. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



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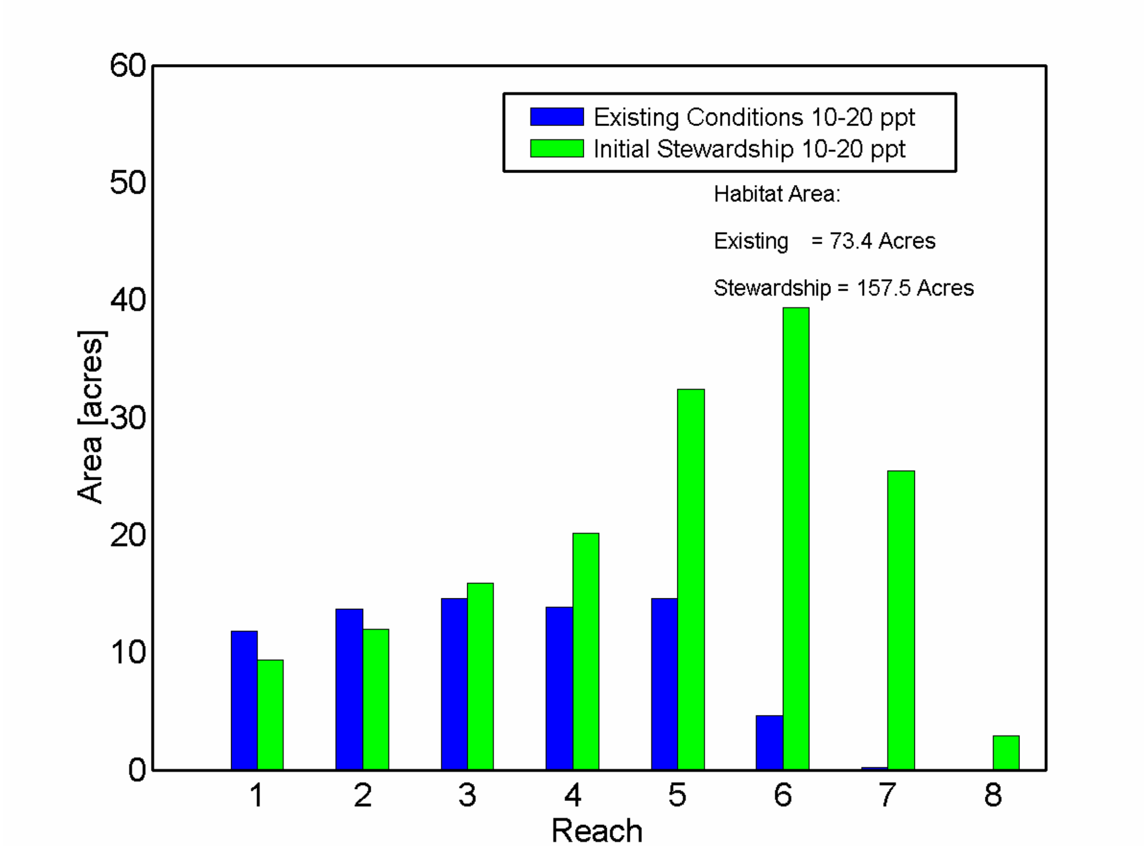
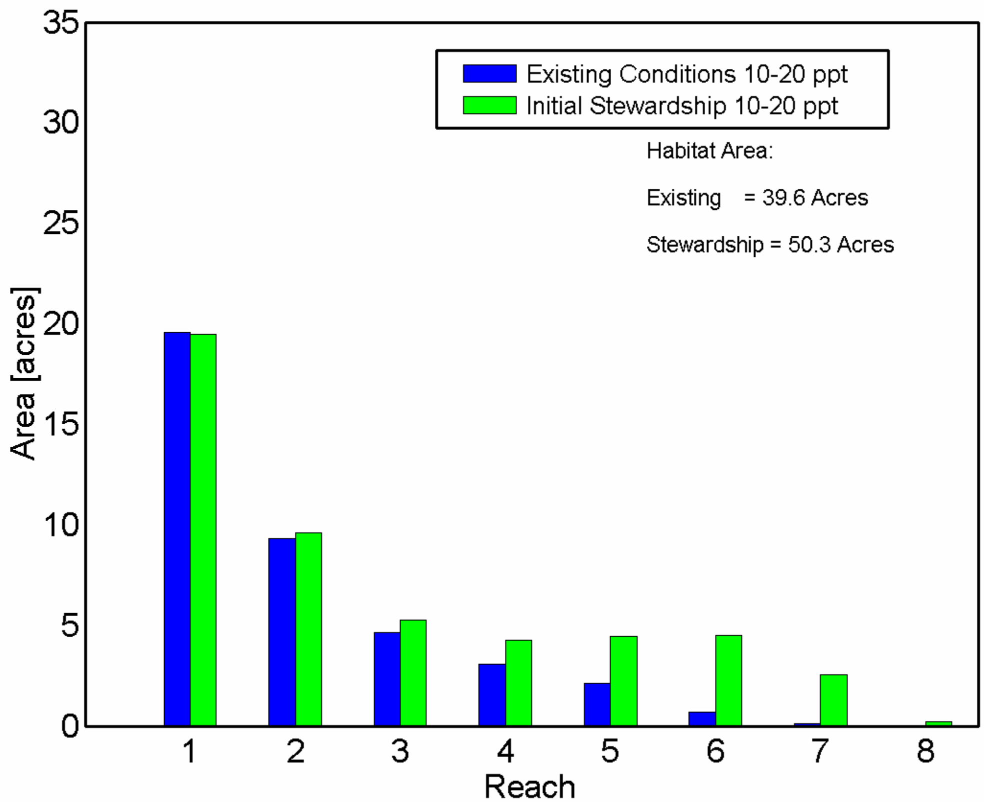


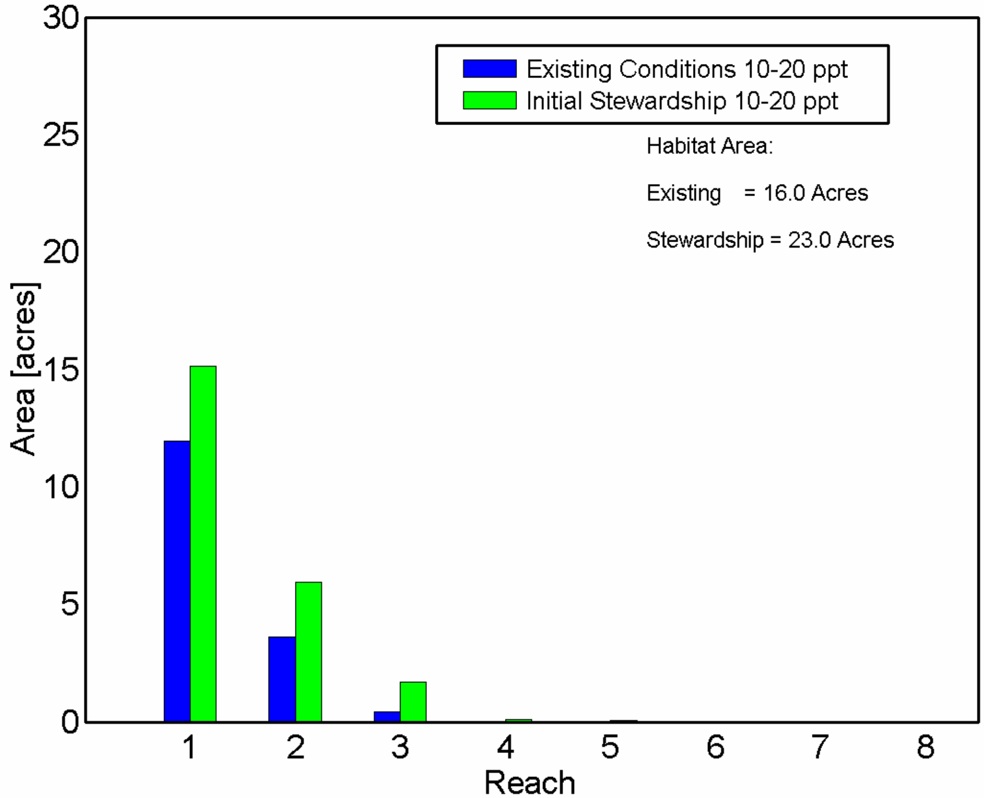
Note: Adult bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 20 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix D, Figure 8. Predicted adult bay shrimp preferred habitat area in Guadalupe Slough in December. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



Note: Adult bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 20 ppt. Predicted based on 1994 and 1995 weather and tidal conditions.

Appendix D, Figure 9. Predicted adult bay shrimp preferred habitat area in Guadalupe Slough in January. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



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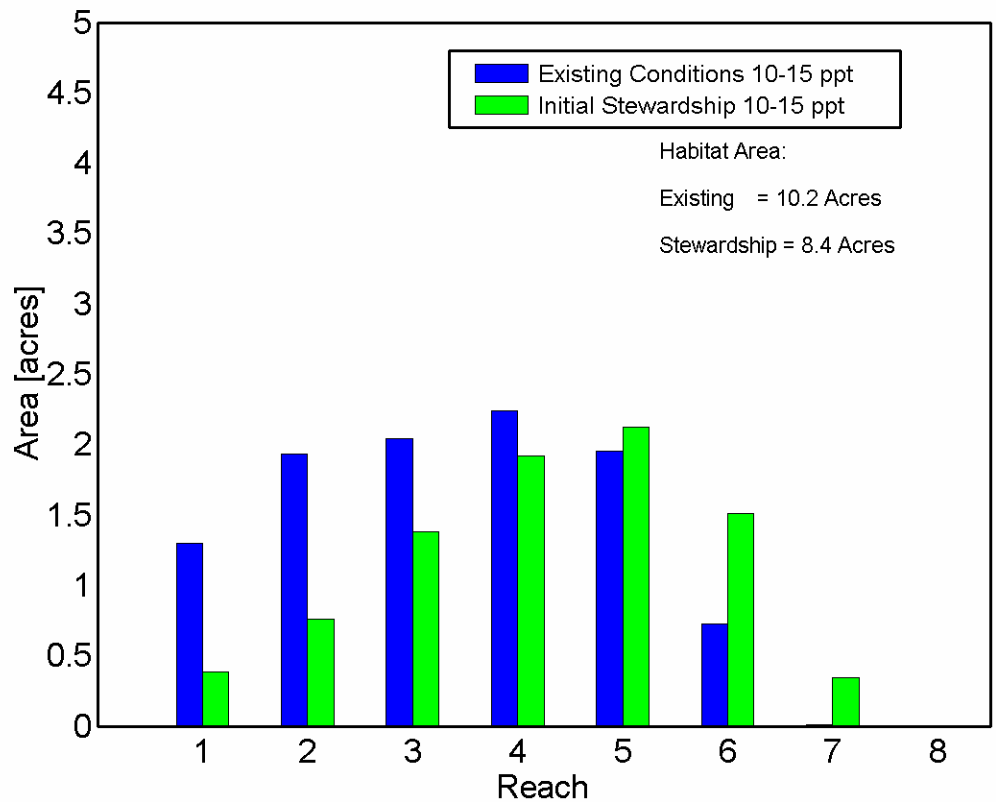
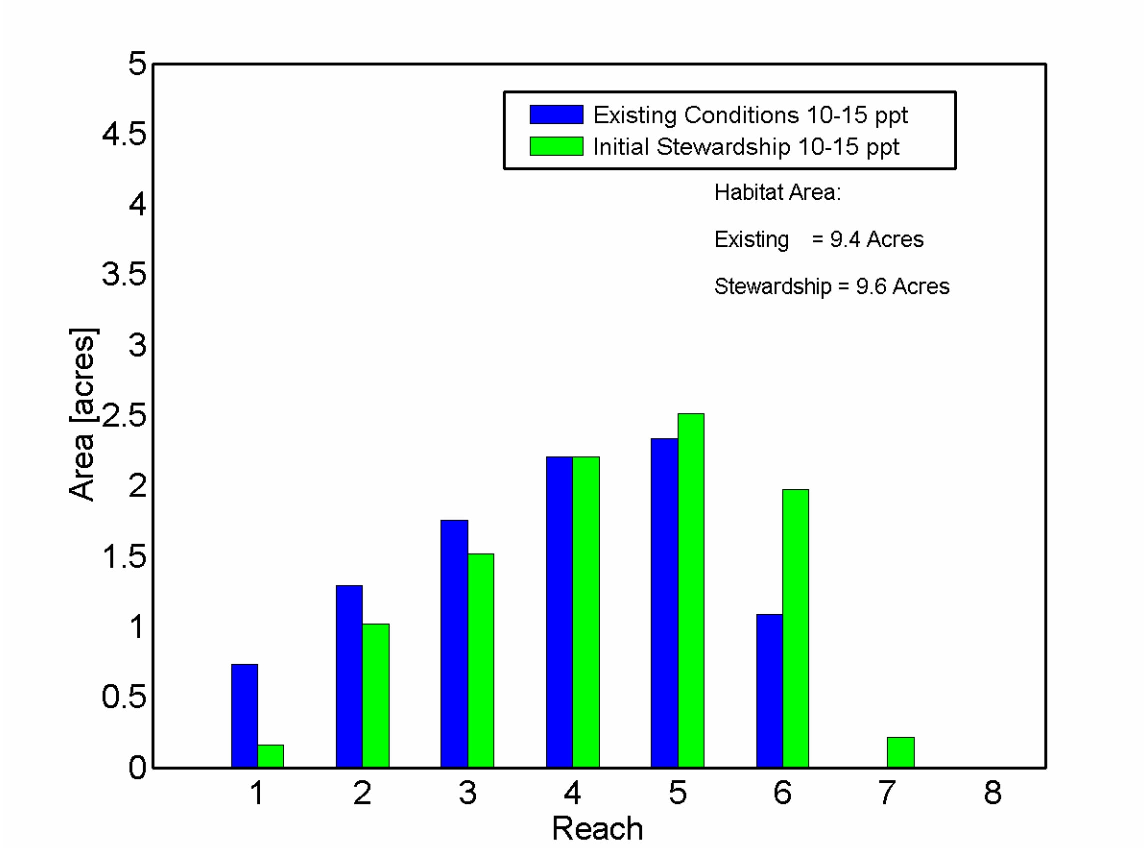
Appendix D, Figure 10. Predicted adult bay shrimp preferred habitat area in Guadalupe Slough in February. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at salinities observed in 2002.



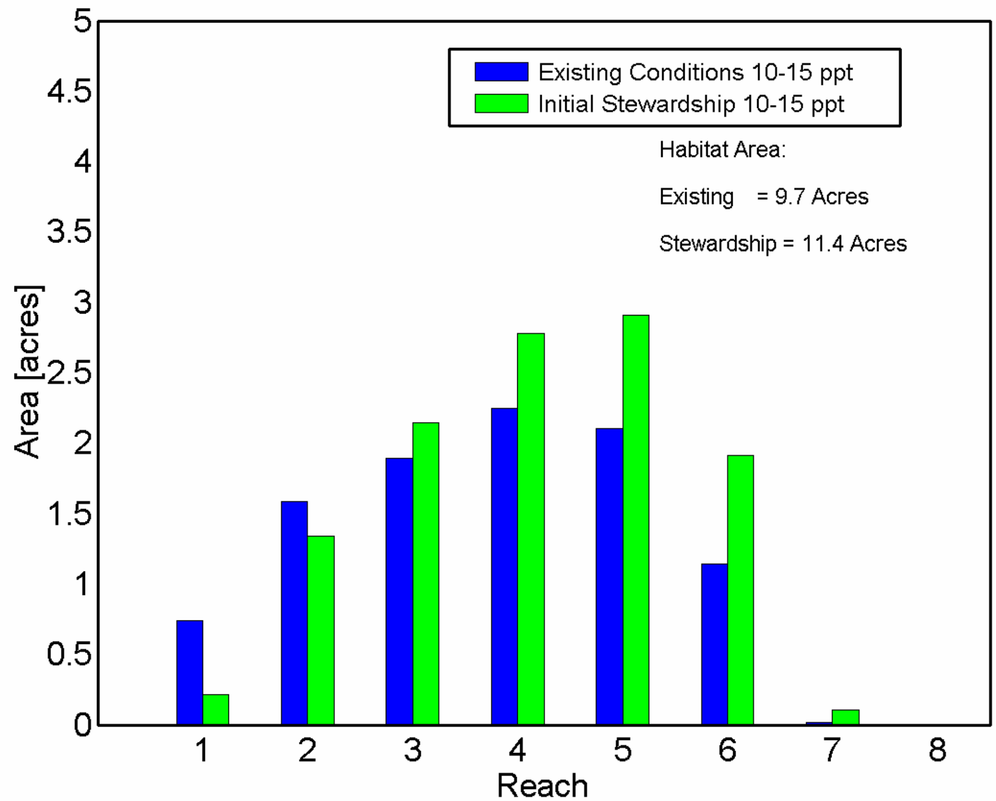
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994-1995 weather and tidal conditions.

Appendix E, Figure 1. Predicted juvenile bay shrimp preferred habitat area in the Alameda Flood Control Channel in May, the second month of the Initial Release Period. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at proposed maximum salinities.



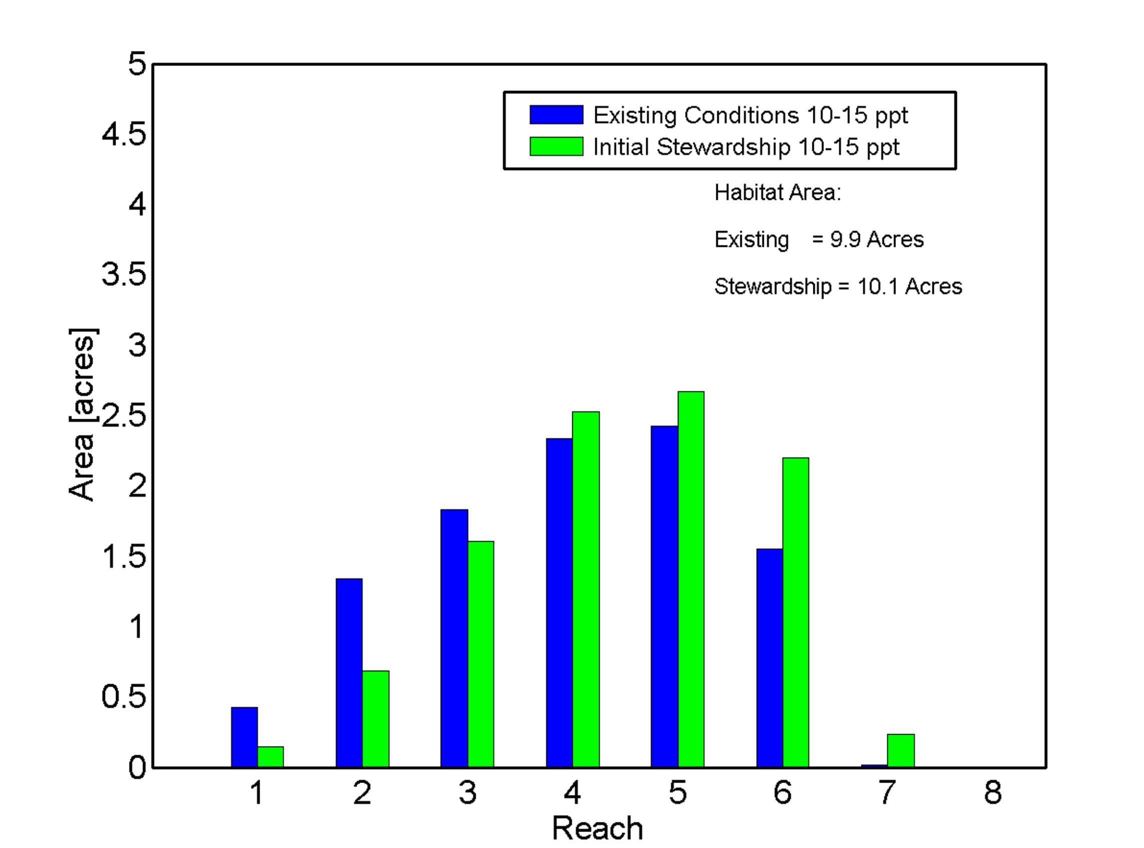
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994-1995 weather and tidal conditions.

Appendix E, Figure 2. Predicted juvenile bay shrimp preferred habitat area in the Alameda Flood Control Channel in June. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at proposed maximum salinities.



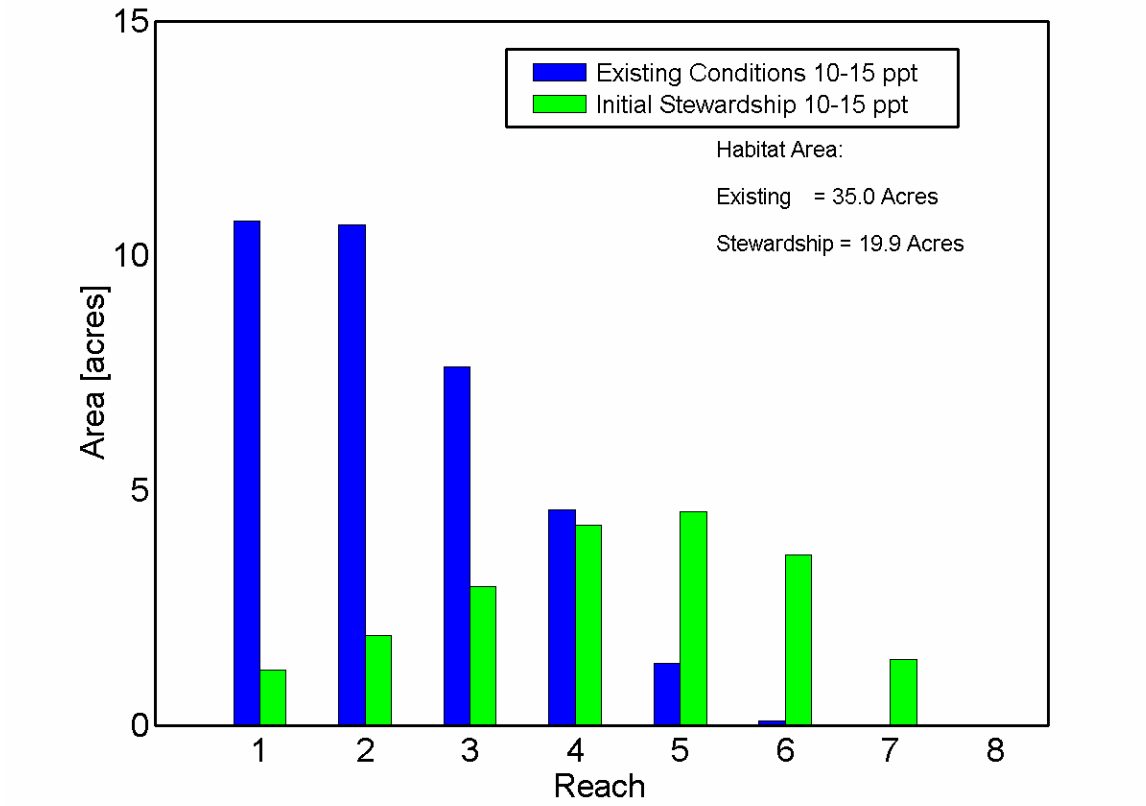
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994-1995 weather and tidal conditions.

Appendix E, Figure 3. Predicted juvenile bay shrimp preferred habitat area in the Alameda Flood Control Channel in July. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at proposed maximum salinities.



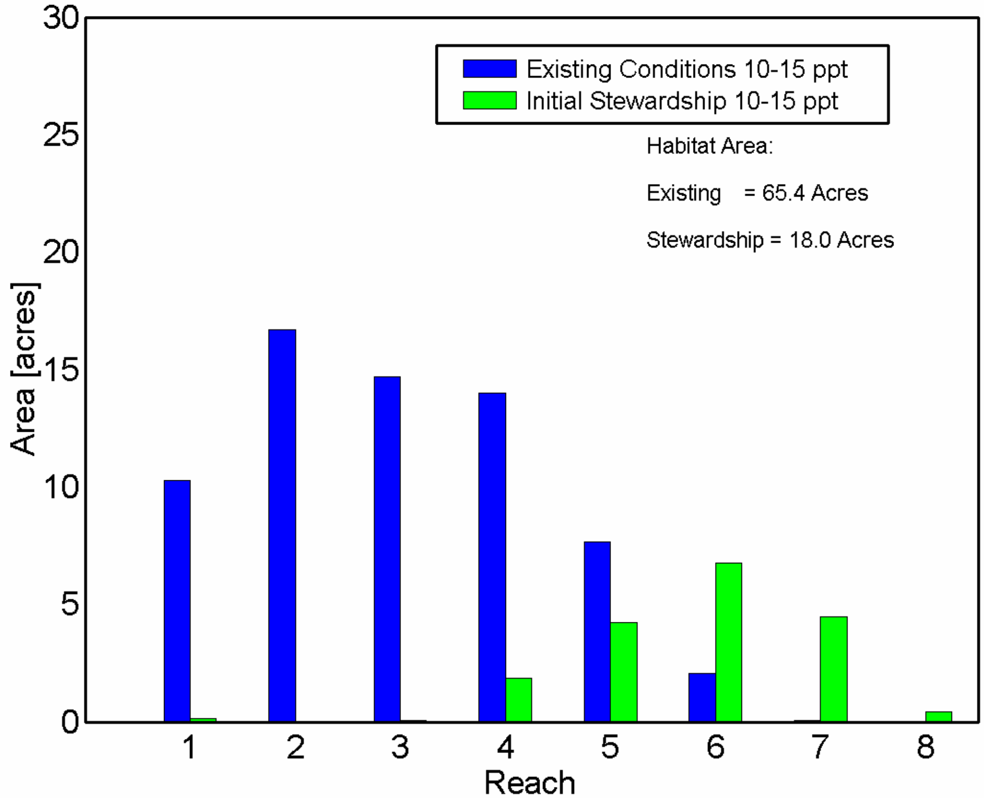
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994-1995 weather and tidal conditions.

Appendix E, Figure 4. Predicted juvenile bay shrimp preferred habitat area in the Alameda Flood Control Channel in August. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at proposed maximum salinities.



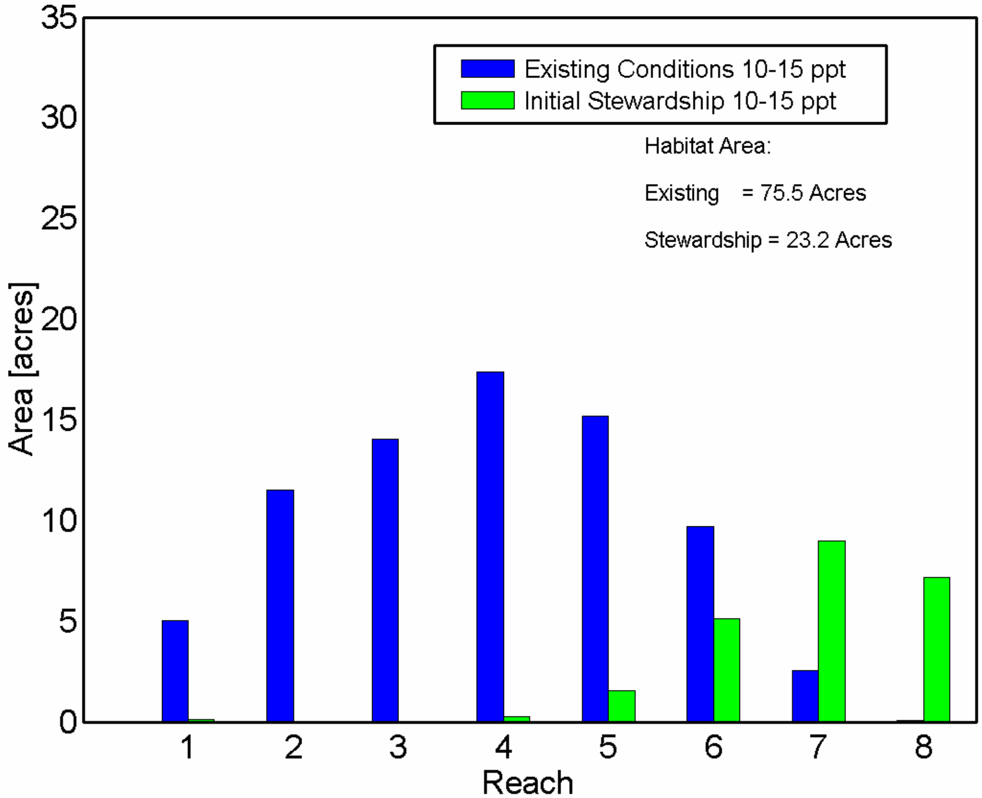
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994-1995 weather and tidal conditions.

Appendix F, Figure 1. Predicted juvenile bay shrimp preferred habitat area in Alviso Slough in May, the second month of the Initial Release Period. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at proposed maximum salinities.



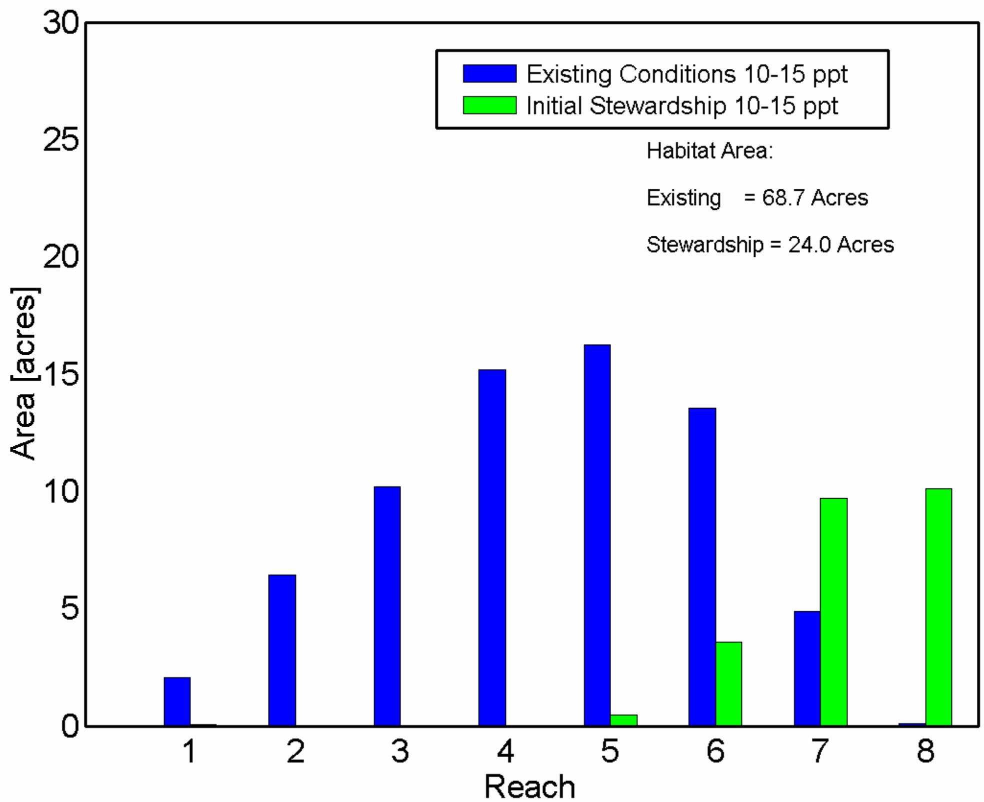
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994-1995 weather and tidal conditions.

Appendix F, Figure 2. Predicted juvenile bay shrimp preferred habitat area in Alviso Slough in June. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at proposed maximum salinities.



Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994-1995 weather and tidal conditions.

Appendix F, Figure 3. Predicted juvenile bay shrimp preferred habitat area in Alviso Slough in July. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at proposed maximum salinities.



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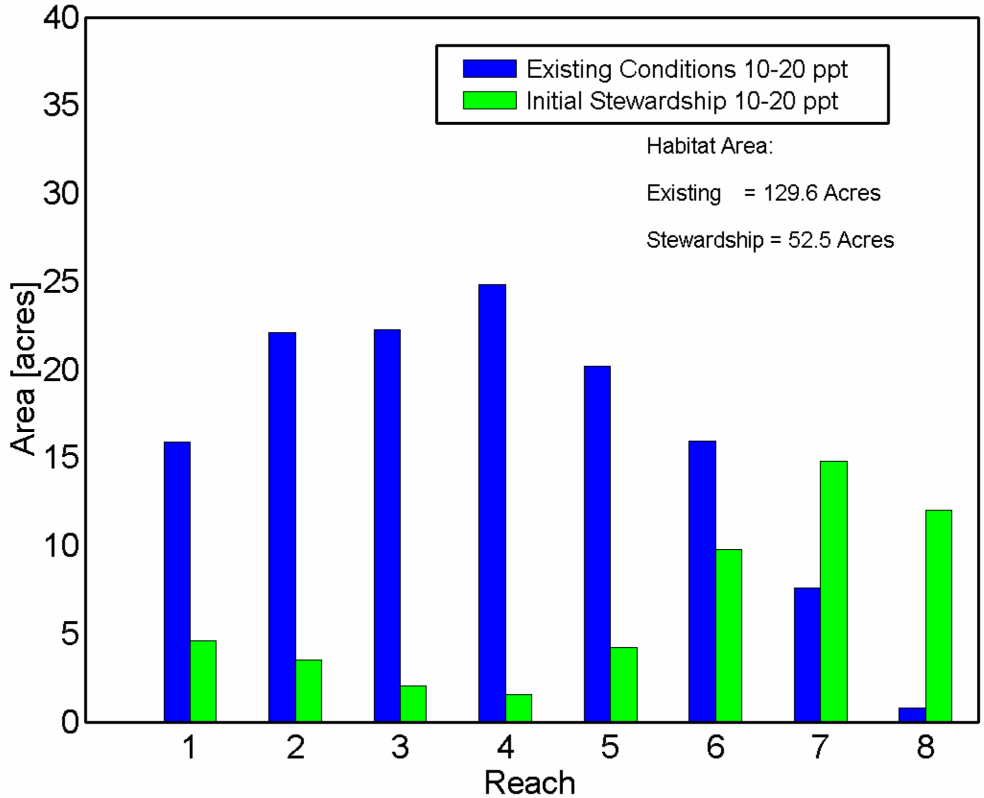
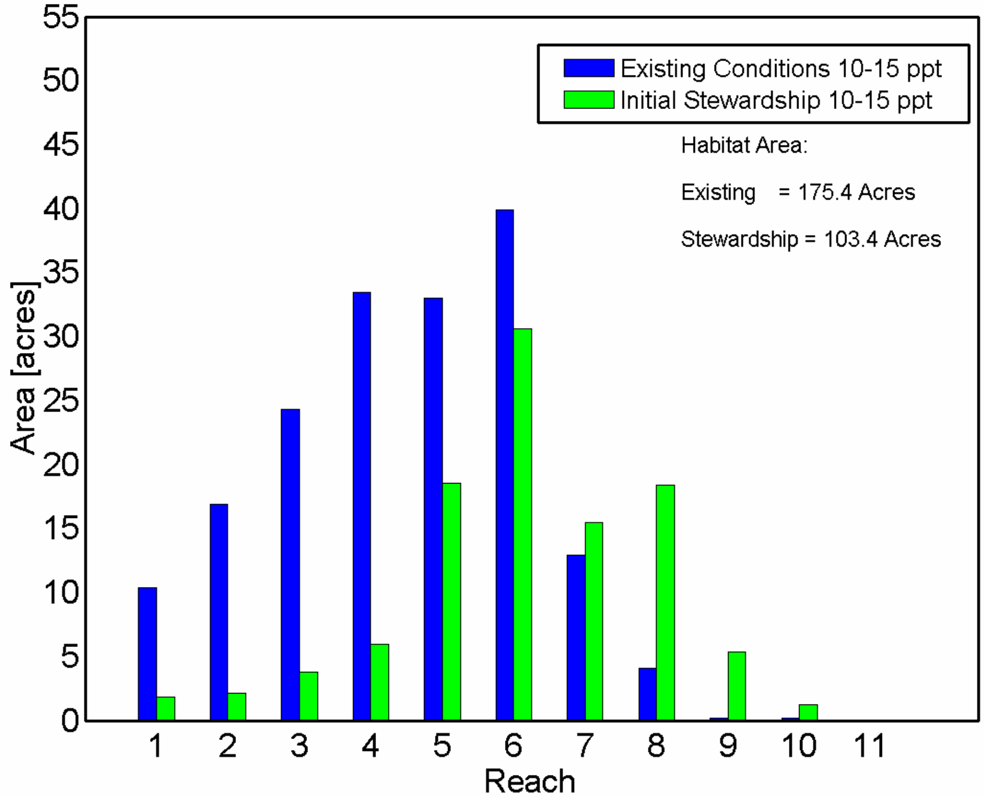


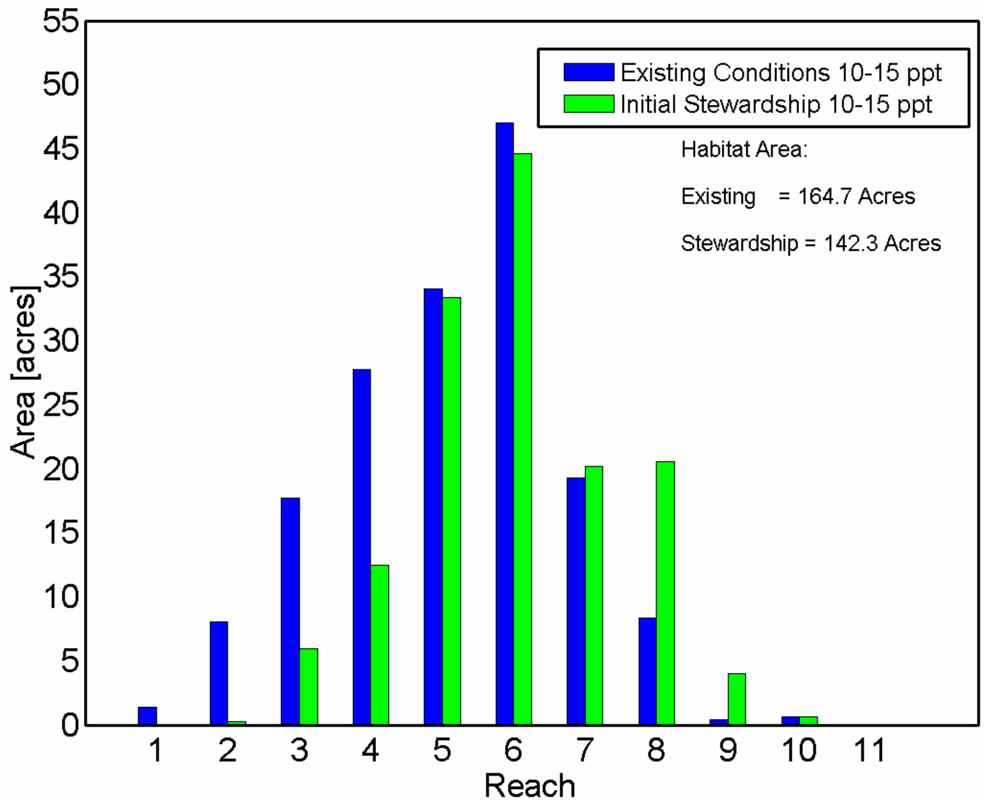
Note: Adult bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 20 ppt. Predicted based on 1994-1995 weather and tidal conditions.

Appendix F, Figure 5. Predicted adult bay shrimp preferred habitat area in Alviso Slough in September. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at proposed maximum salinities.



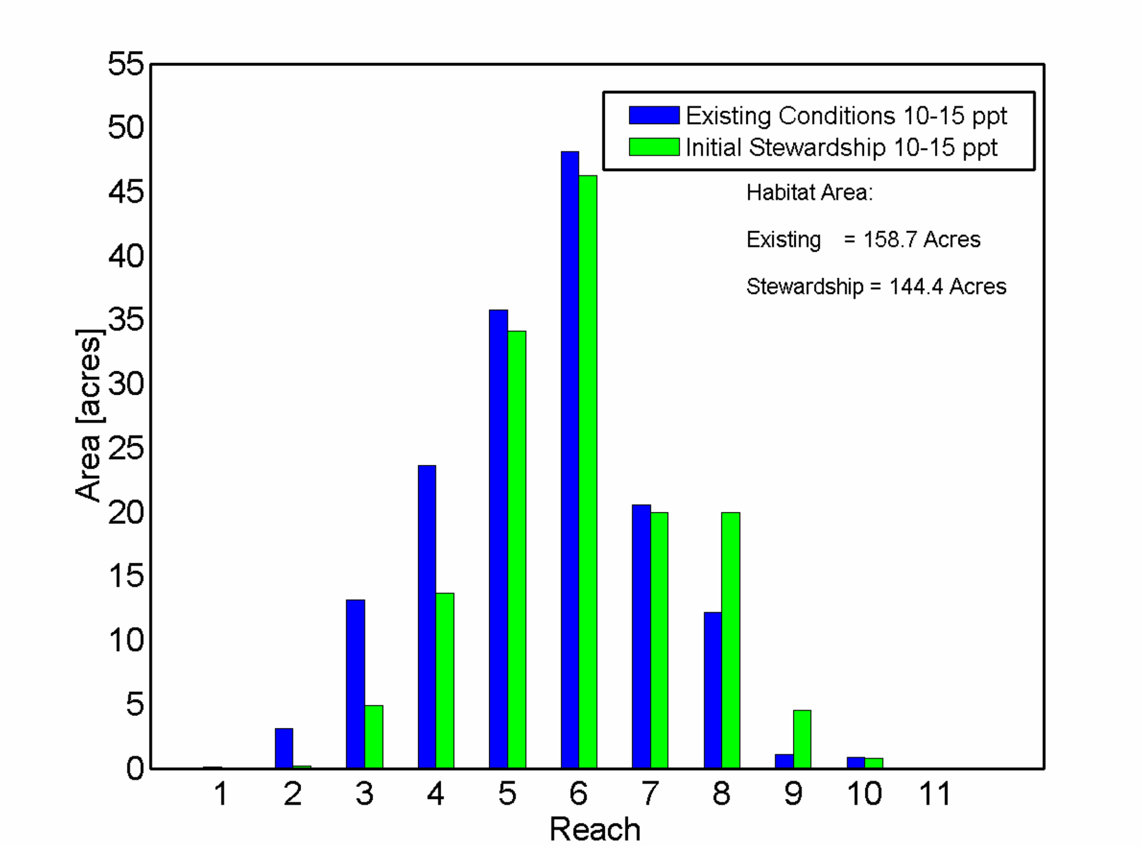
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994-1995 weather and tidal conditions.

Appendix G, Figure 1. Predicted juvenile bay shrimp preferred habitat area in Coyote Creek in May, the second month of the Initial Release Period. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at proposed maximum salinities.



Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994-1995 weather and tidal conditions.

Appendix G, Figure 2. Predicted juvenile bay shrimp preferred habitat area in Coyote Creek in June. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at proposed maximum salinities.



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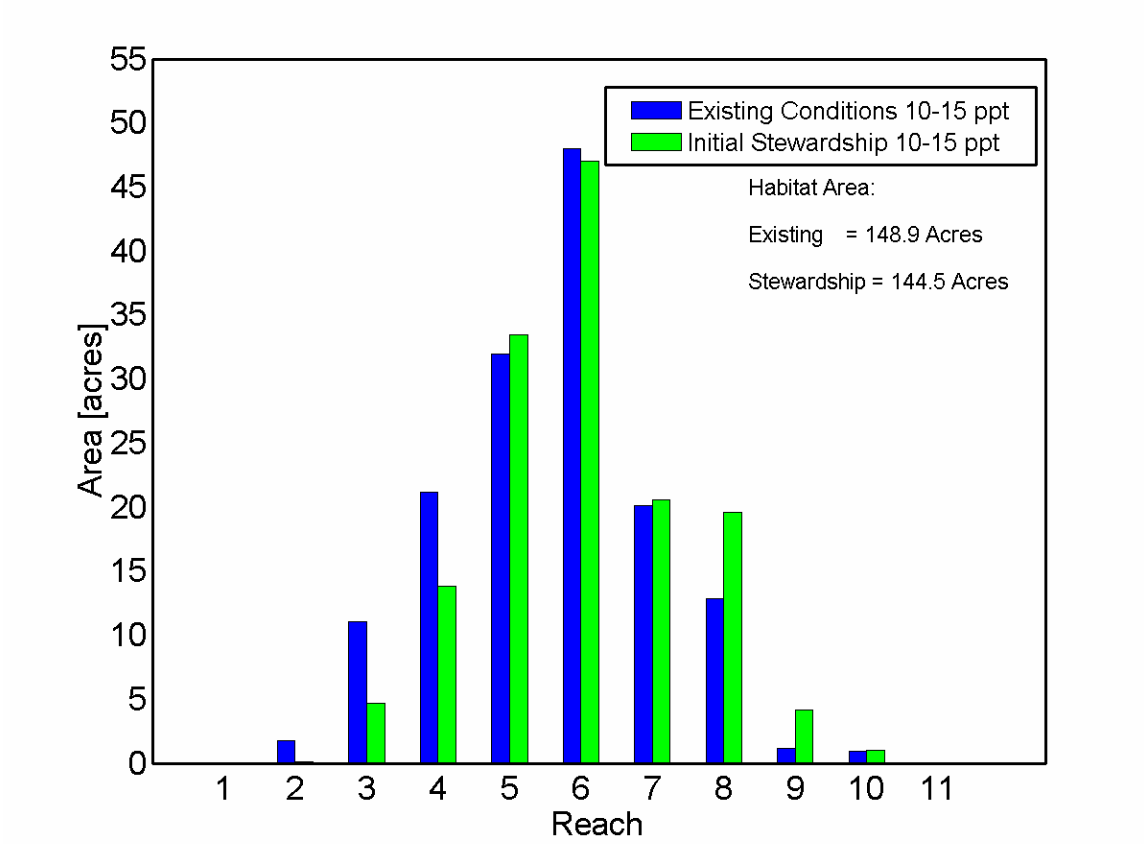

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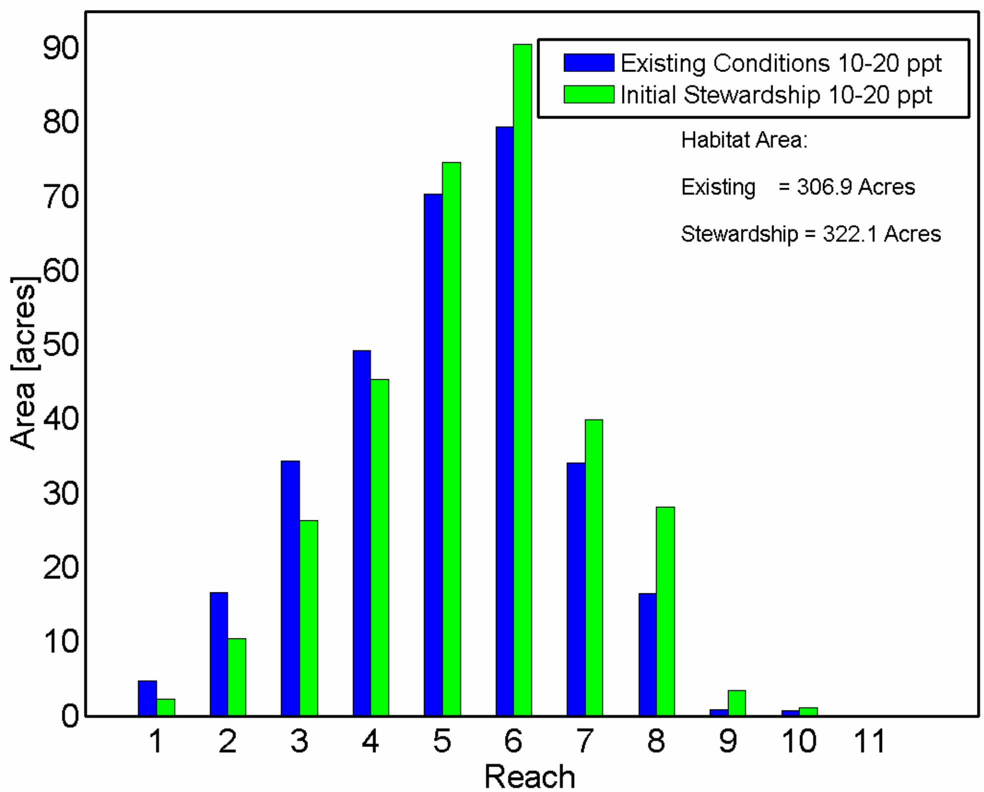

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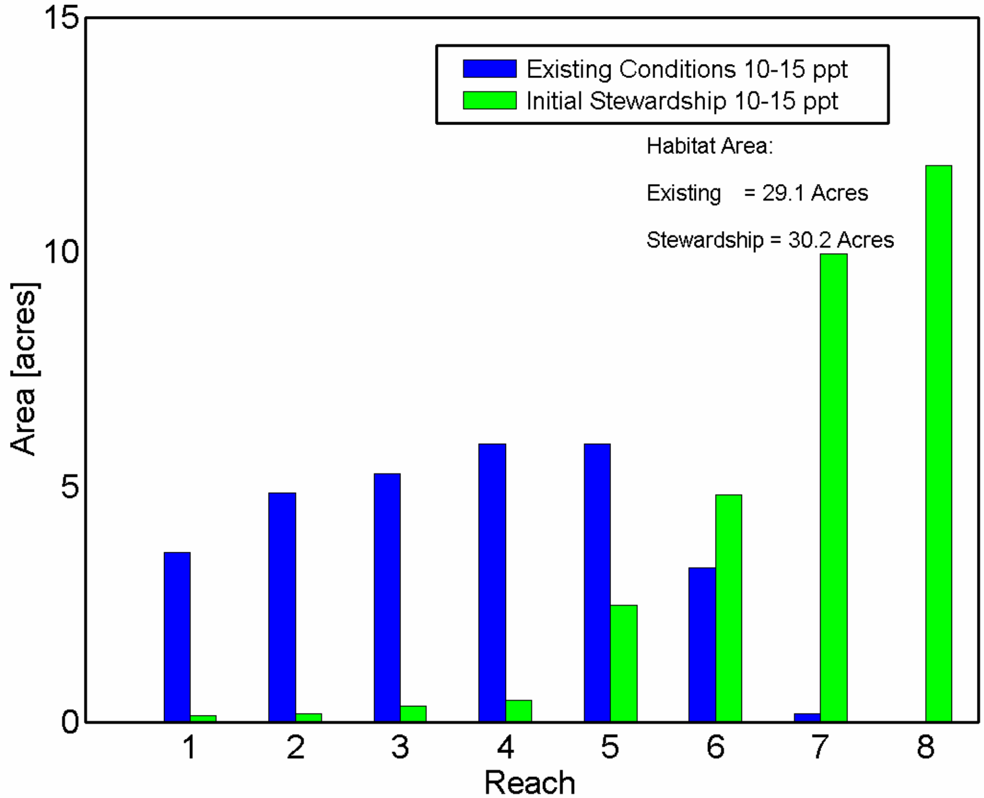
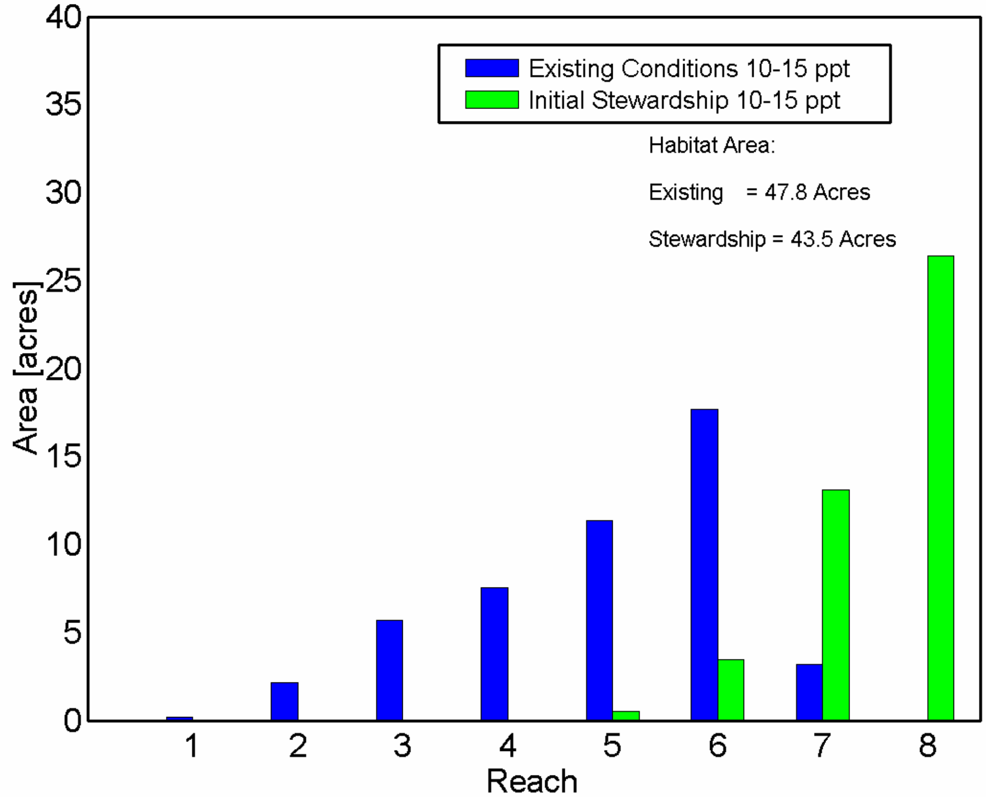


Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994-1995 weather and tidal conditions.

Appendix H, Figure 1. Predicted juvenile bay shrimp preferred habitat area in Guadalupe Slough in May, the second month of the Initial Release Period. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on April 1 at proposed maximum salinities.



Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994-1995 weather and tidal conditions.

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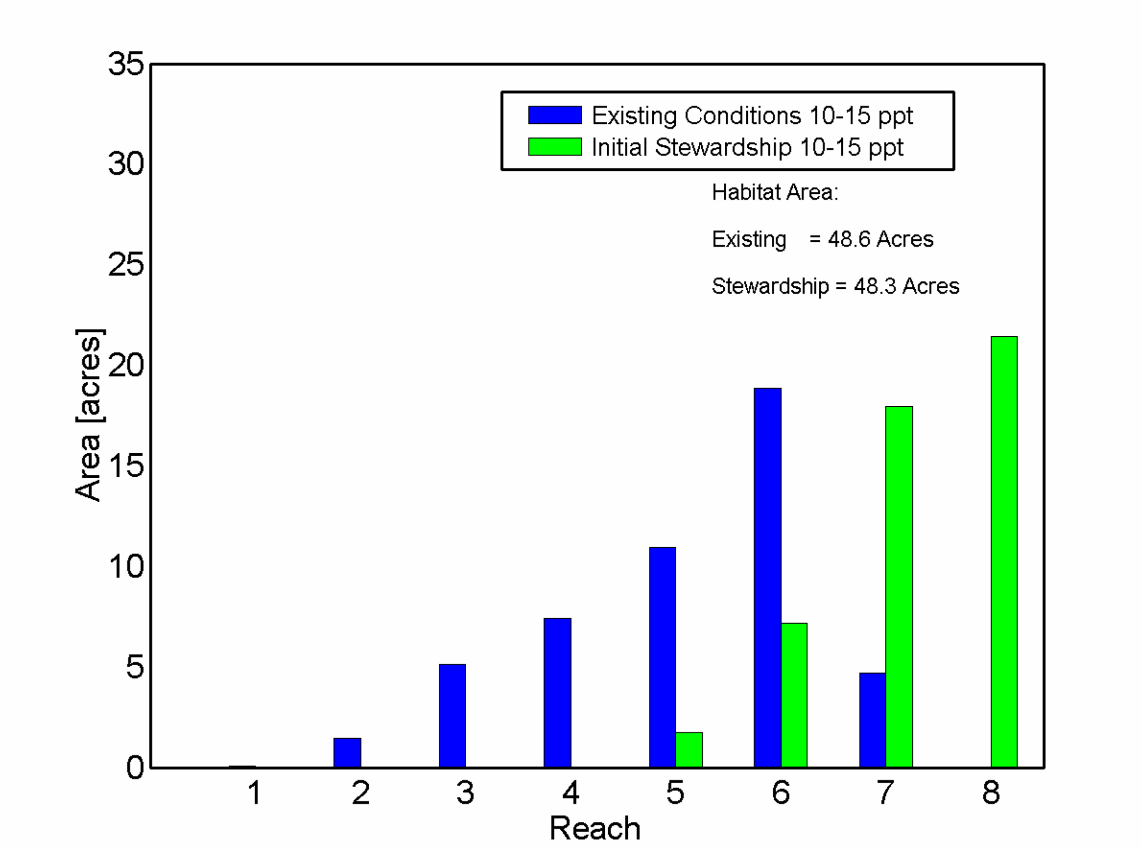

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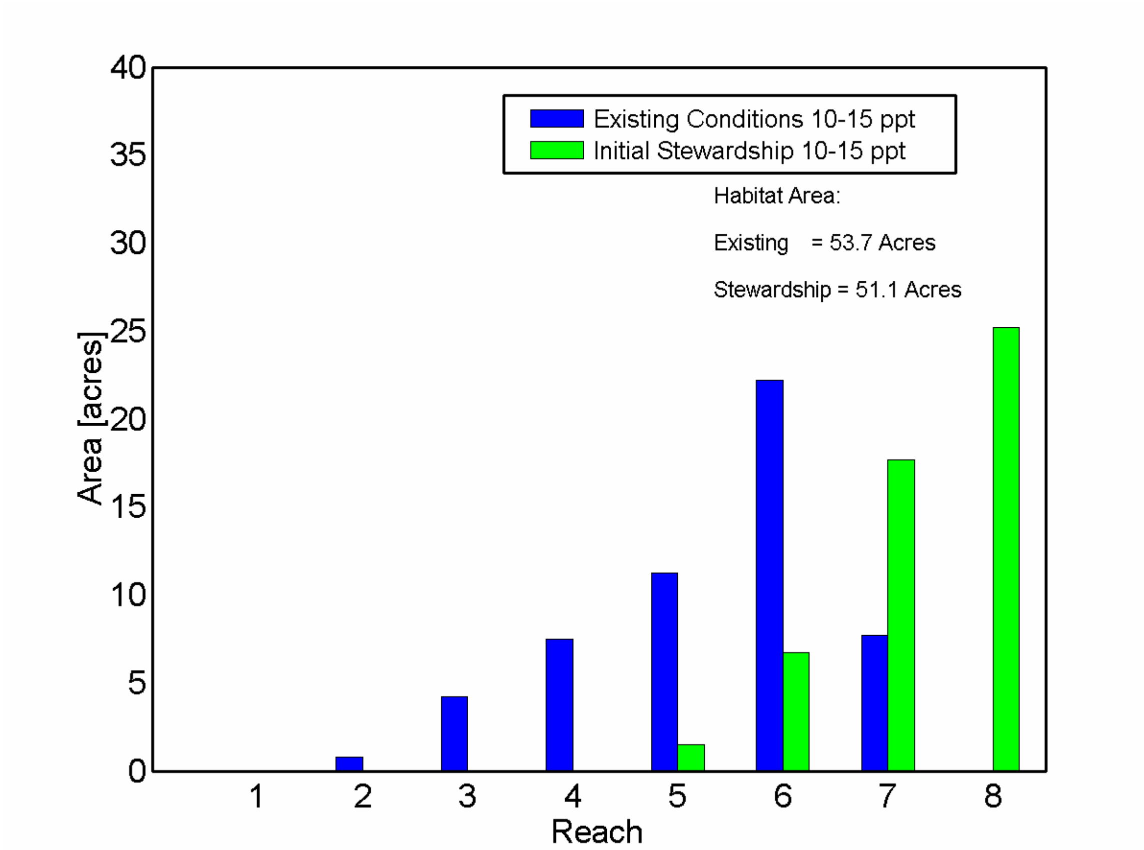

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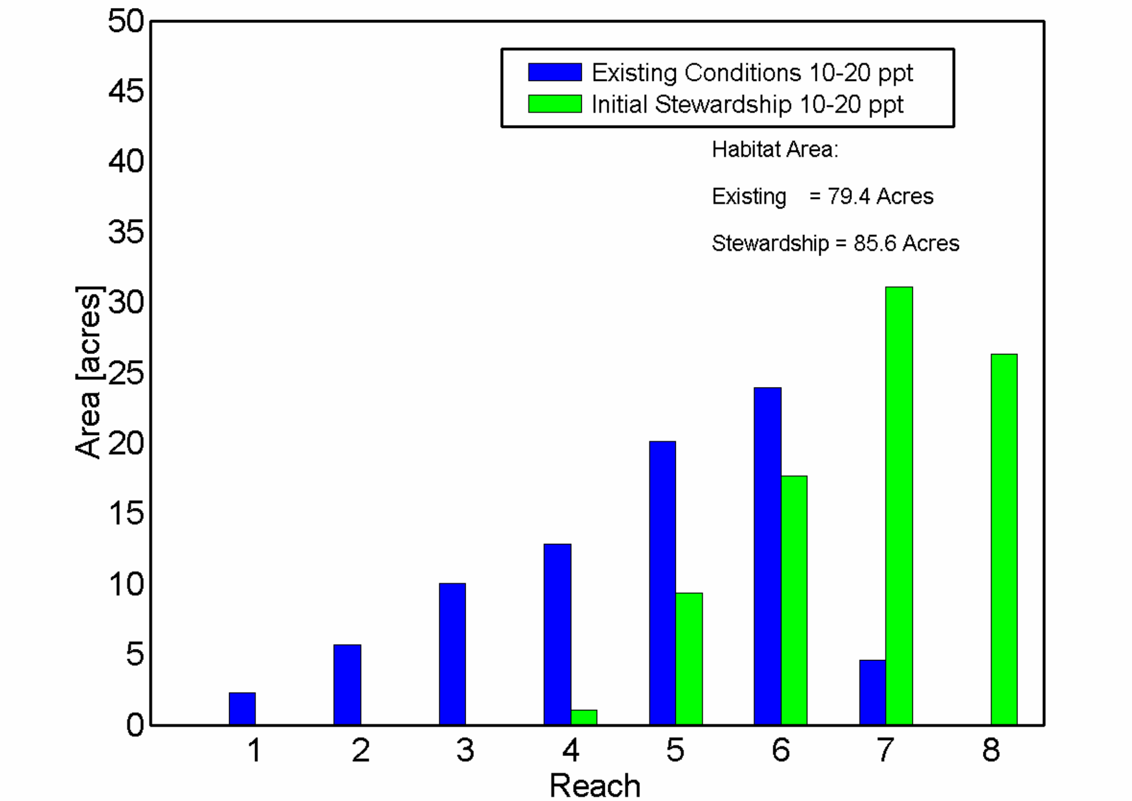

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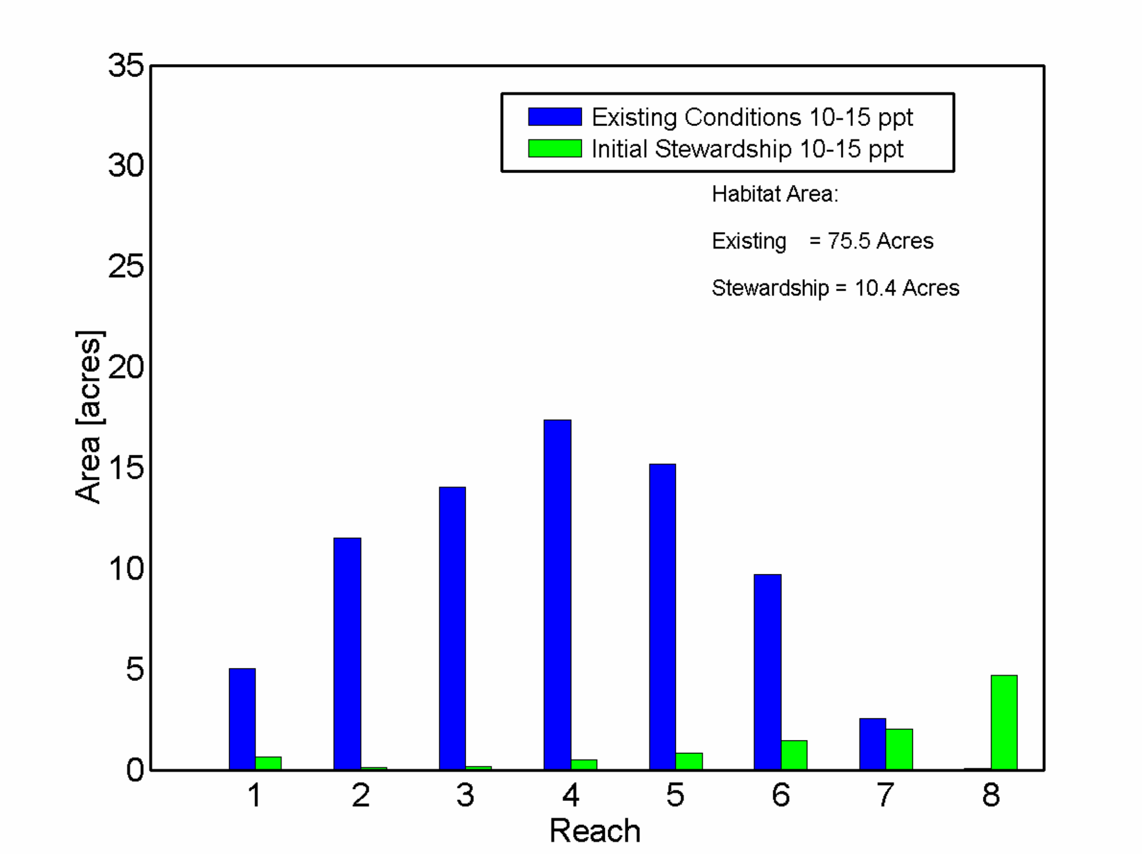
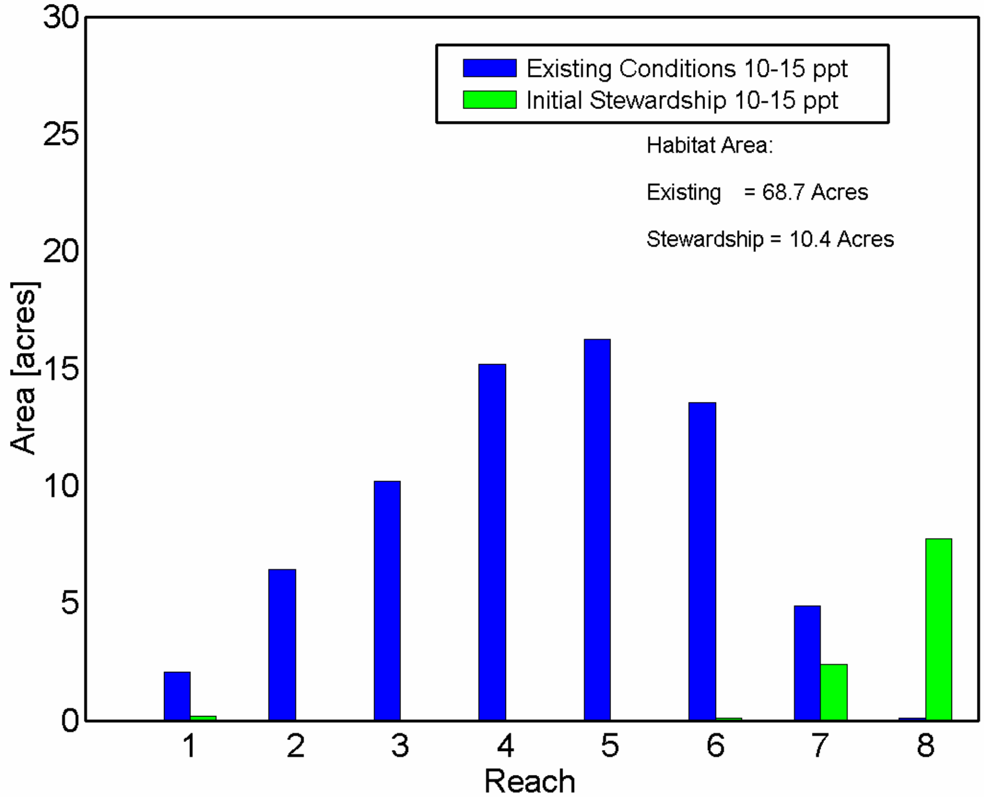


Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994-1995 weather and tidal conditions.

Appendix I, Figure 1. Predicted juvenile bay shrimp preferred habitat area in Alviso Slough in July, the first month of the Phased Initial Release Period. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on July 1 at proposed maximum salinities.



Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994-1995 weather and tidal conditions.

Appendix I, Figure 2. Predicted juvenile bay shrimp preferred habitat area in Alviso Slough in August. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on July 1 at proposed maximum salinities.

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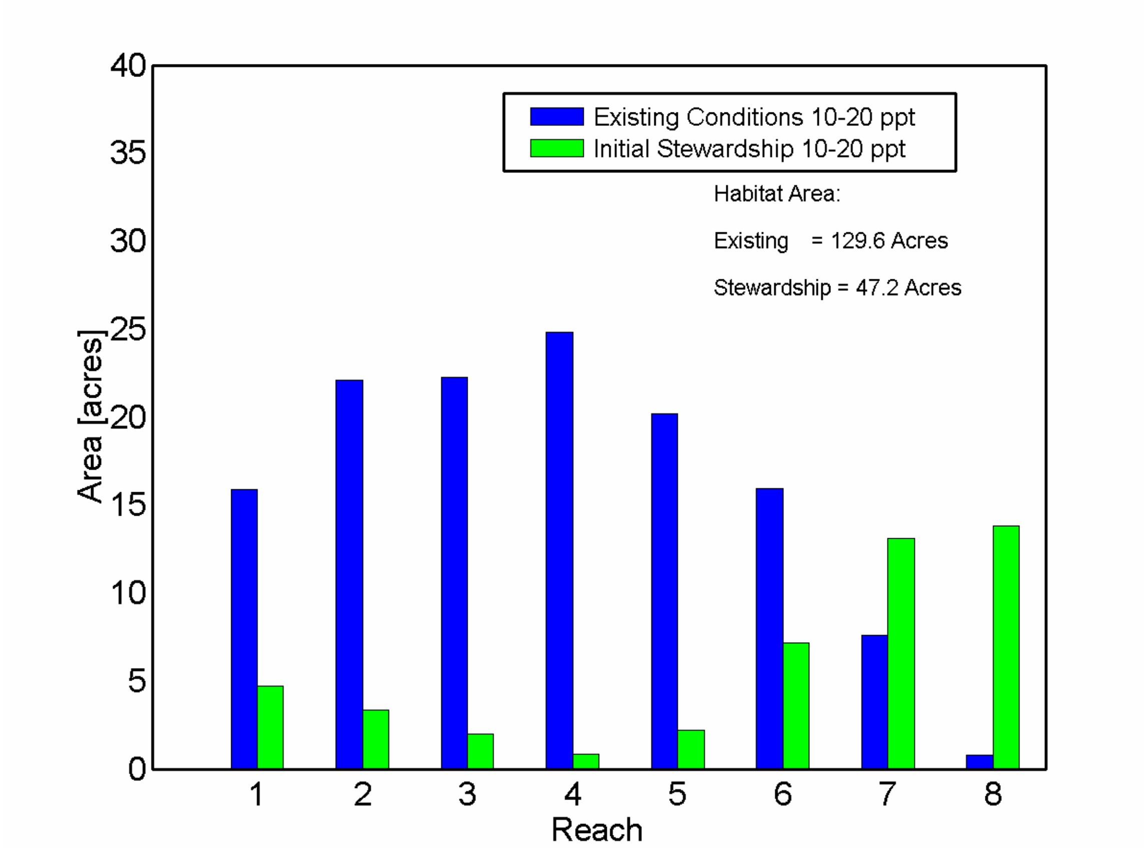

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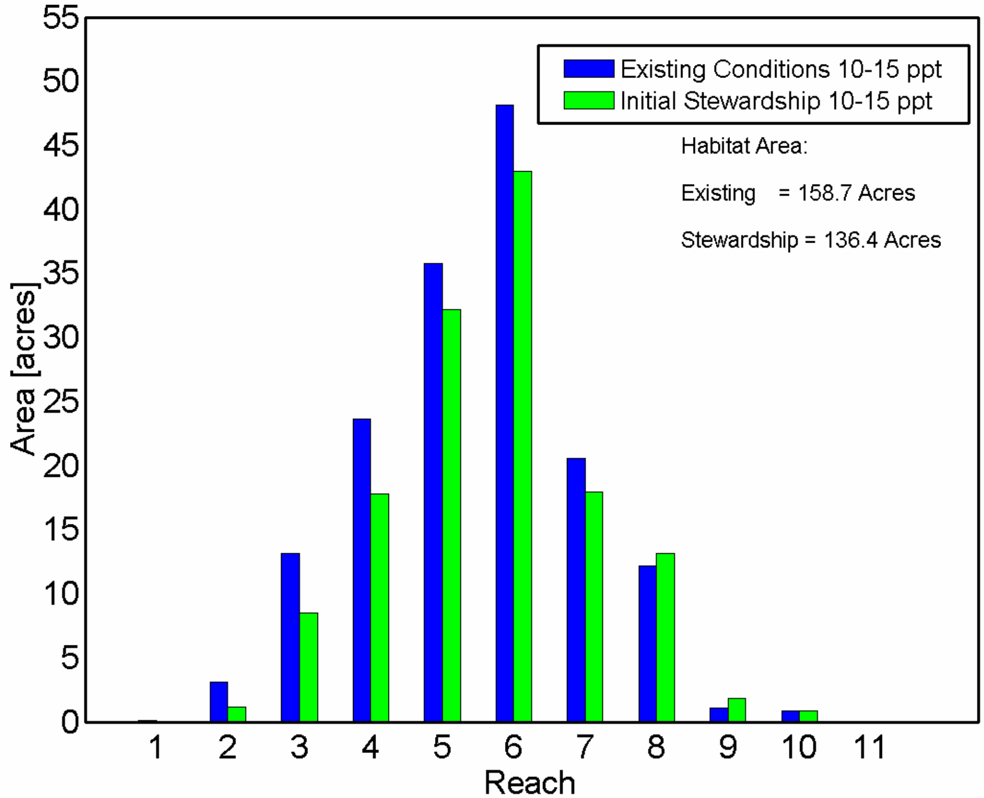
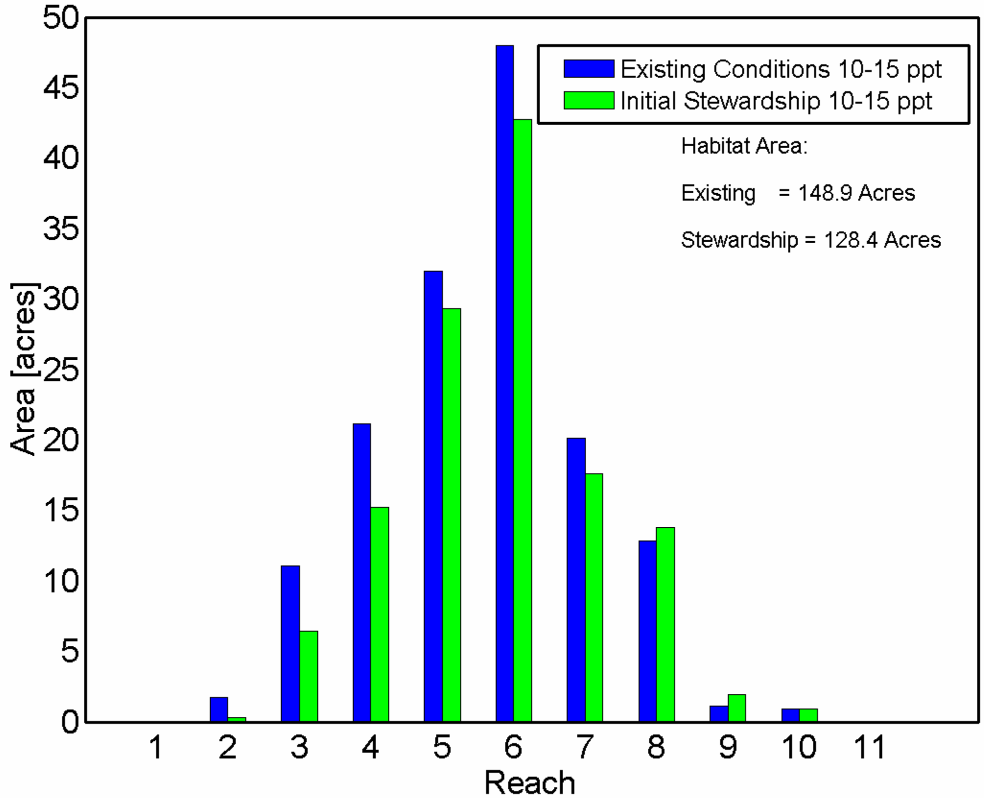


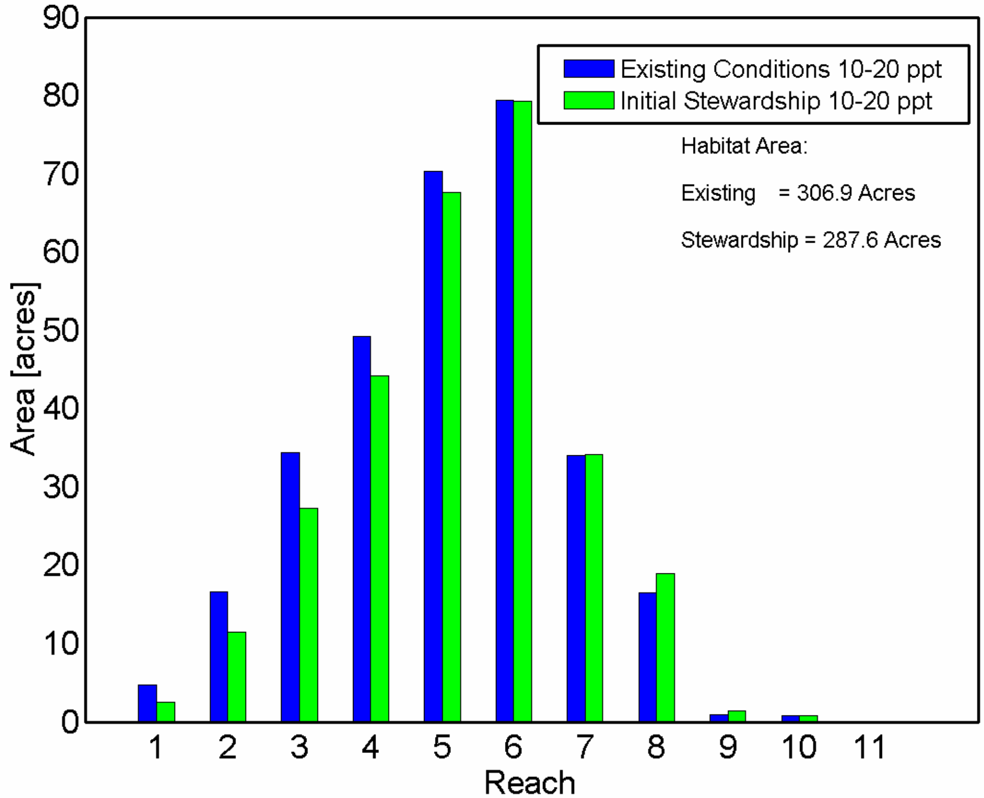
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994-1995 weather and tidal conditions.

Appendix J, Figure 1. Predicted juvenile bay shrimp preferred habitat area in Coyote Creek in July, the first month of the Phased Initial Release Period. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on July 1 at proposed maximum salinities.



Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994-1995 weather and tidal conditions.

Appendix J, Figure 2. Predicted juvenile bay shrimp preferred habitat area in Coyote Creek in August. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on July 1 at proposed maximum salinities.



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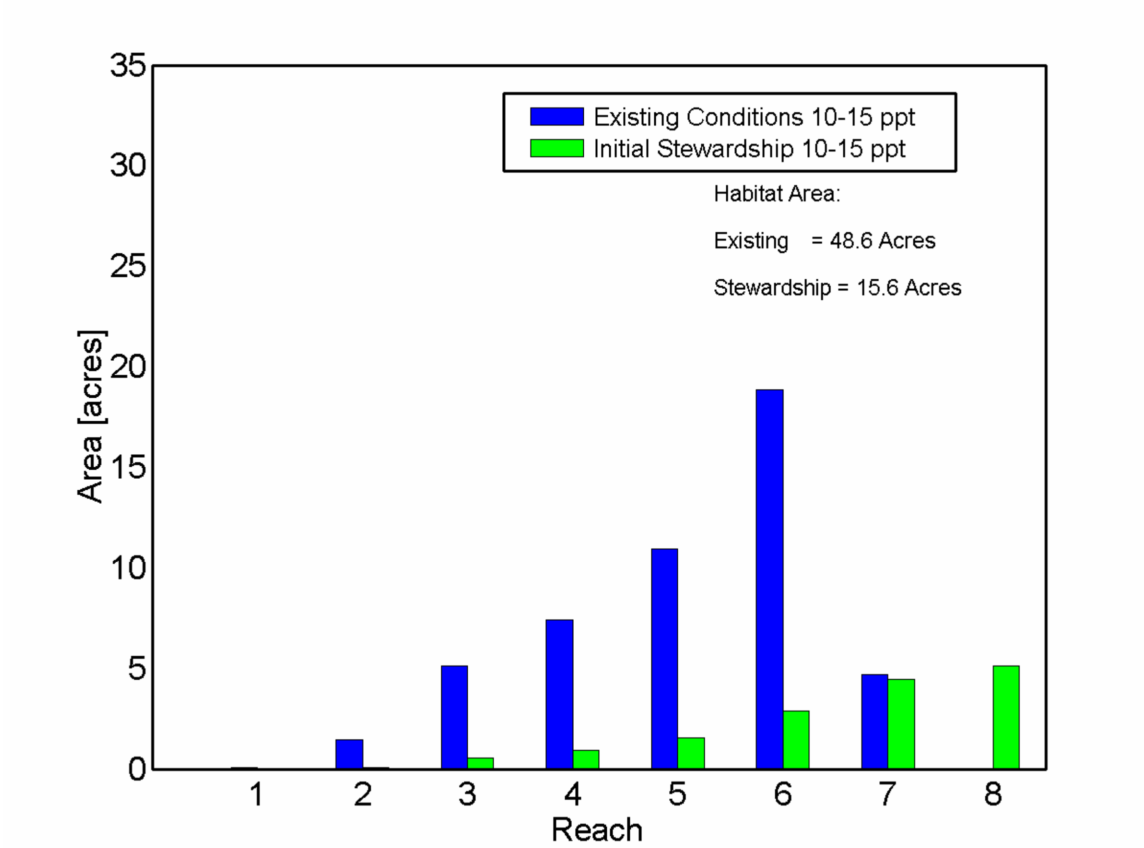
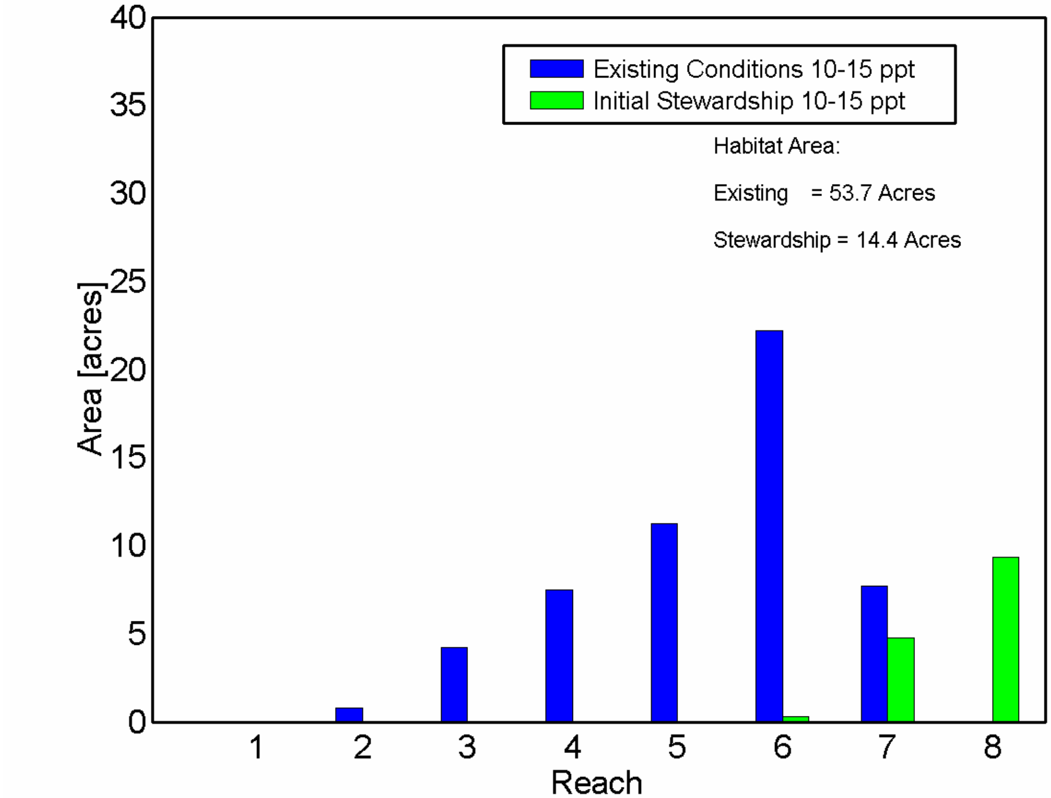


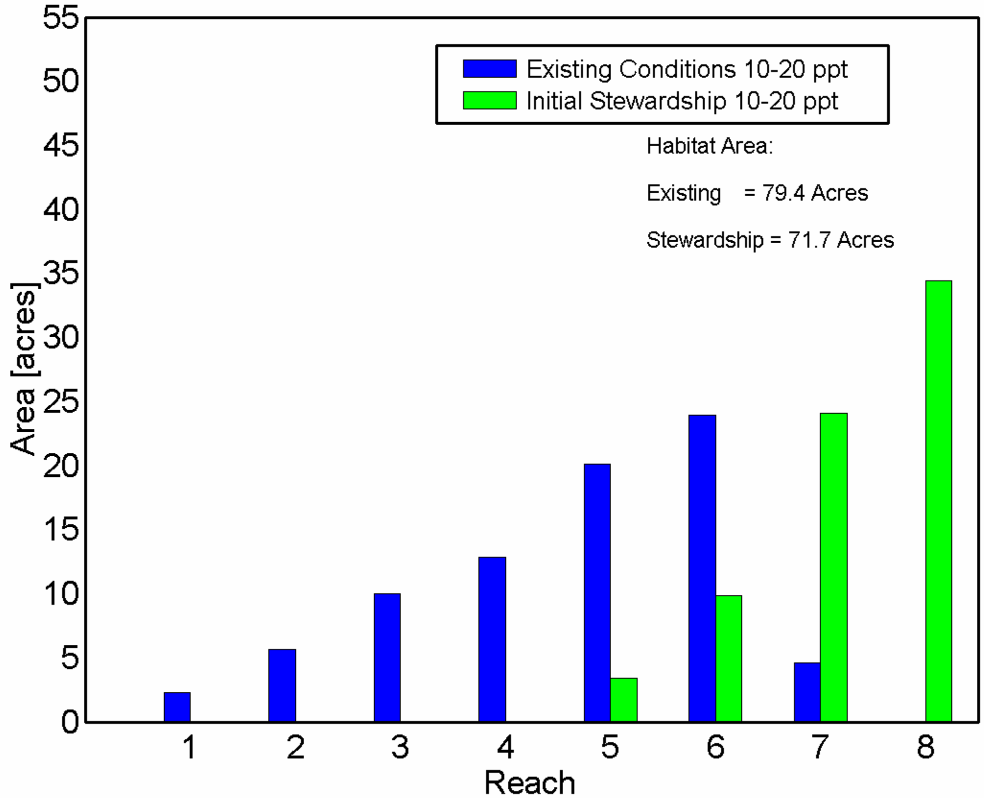
Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994-1995 weather and tidal conditions.

Appendix K, Figure 1. Predicted juvenile bay shrimp preferred habitat area in Guadalupe Slough in July, the first month of the Phased Initial Release Period. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on July 1 at proposed maximum salinities.



Note: Juvenile bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 15 ppt. Predicted based on 1994-1995 weather and tidal conditions.

Appendix K, Figure 2. Predicted juvenile bay shrimp preferred habitat area in Guadalupe Slough in August. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on July 1 at proposed maximum salinities.



Note: Adult bay shrimp preferred habitat area computed based on average bottom salinity between 10 and 20 ppt. Predicted based on 1994-1995 weather and tidal conditions.

Appendix K, Figure 3. Predicted adult bay shrimp preferred habitat area in Guadalupe Slough in September. Comparison between existing conditions and Initial Stewardship conditions assuming pond discharges commence on July 1 at proposed maximum salinities.

Jennifer Nachmanoff
Cultural Resources Specialist
1516 Duke Drive
Davis, CA 95616 (530) 757-6249
FAX: (413-653-0655)/email: jennach@dcn.org

May 19, 2003

Ms. Debbie Pilas-Treadway
Native American Heritage Commission
915 Capital Mall, Room 364
Sacramento, California 95814

Subject: REQUEST FOR SACRED LANDS FILE SEARCH AND NATIVE AMERICAN REFERRALS -SOUTH BAY SALT PONDS INITIAL STEWARDSHIP PROJECT, ALAMEDA, SANTA CLARA, AND SAN MATEO COUNTIES, CALIFORNIA

Dear Ms. Pilas-Treadway

The U.S. Fish and Wildlife Service (USFWS) and the California Department of Fish and Game (CDFG) are preparing a joint Environmental Impact Statement/ Environmental Impact Report (EIS/EIR) to address the potential impacts of the Initial Stewardship Project for the South Bay Salt Ponds (ISP) in Alameda, Santa Clara, and San Mateo Counties, California. Life Sciences! Inc. (LSI) has been contracted by the agencies to prepare the EIR/EIS and I am assisting Life Sciences! Inc. with this project. Maps showing the location of the project are attached.

The USFWS and CDFG are acquiring approximately 15,100 acres of salt production ponds from Cargill Salt Corporation. The proposed South Bay Salt Ponds ISP is intended to provide for management of the acquisition lands from the time management responsibility is transferred by Cargill to the USFWS and CDFG, until a long-term restoration and management plan for the South Bay is completed. It is anticipated that the planning and design process for long-term restoration, and thus the duration of the ISP, will require at least five years.

The objectives of the proposed ISP include:

1. Cease salt production.
2. Circulate Bay water through the ponds and introduce tidal hydrology to ponds where feasible.
3. Maintain existing open water and wetland habitat for the benefit of wildlife, including habitat for migratory shorebirds and waterfowl and resident breeding species.
4. Maintain ponds in a restorable condition to facilitate future long term restoration.
5. Meet all regulatory requirements, including discharge requirements to maintain water quality standards in the South Bay.

Proposed changes to existing operations include:

1. Circulating bay waters through reconfigured pond systems and releasing pond contents into the Bay. The plan will require installing new water control features, consisting of intake structures, outlet structures and additional pumps to maintain existing shallow open water habitat.
2. Managing a limited number of ponds as seasonal wetlands, to reduce management costs and optimize habitat for migratory shorebirds and waterfowl.

3. Managing different summer and winter water levels in a limited number of ponds to reduce management costs and optimize habitat for migratory shorebirds and waterfowl.
4. Restoration of three ponds to muted tidal or full tidal influence.
5. Managing several ponds in the Alviso system as "batch ponds", where salinity levels would be allowed to rise in order to support specific wildlife populations.

I am contacting you to request a search of the Sacred Lands File for areas potentially impacted by this project, and also to request a list of Native American representatives who may have an interest in heritage lands or other resources potentially affected by the proposed project.

Please FAX this information to 413-653-0655or mail it to:

Jennifer Nachmanoff
1516 Duke Drive
Davis, California 95616

You can contact me at (530) 757-6249 if you have any questions. Thank you for your help.

Sincerely,

Jennifer Nachmanoff
Cultural Resources Specialist

cc: Lisa Stallings, LSI

Katherine Perez
1234 Luna Lane
Stockton, CA 95206
Tel: (209) 462-2680 Fax: (209) 462-2680

May 27, 2003

Jennifer Nachmanoff
Cultural Resources Specialist
1516 Duke Drive
Davis, CA 95616
Tel: (530) 757-6249
Fax: (413) 653-0655

Re; South Bay Salt Ponds Initial Stewardship Project, Alameda, Santa Clara, and San Mateo Counties, California.

Dear Jennifer Nachmanoff:

The impact of the project has a high potential for impacts to unknown burials.

It is the recommendation of the tribe to try and minimize ground disturbance so as to lessen the potential for impacts to unknown sites. It may even be safe to have monitoring done on just the ground disturbance.

Katherine Perez
Katherine Perez

STATE OF CALIFORNIA Gray Davis, Governor

NATIVE AMERICAN HERITAGE COMMISSION
915 CAPITOL MALL, ROOM 364
SACRAMENTO, CA 95814
(916) 653-4082
Fax (916) 657-5390
Web Site www.nahc.ca.gov

June 16, 2003

Jennifer Nachmanoff
Cultural Resources Specialist
1516 Duke Drive
Davis, CA 95616

Sent by Fax: 413-653-0655
No of Pages: 9

RE: Proposed South Bay Salt Ponds ISP Project; Alameda, San Mateo, Santa Clara and San Joaquin Counties.

Dear Ms. Nachmanoff:

A record search of the sacred land file has failed to indicate the presence of Native American cultural resources in the immediate project area. The absence of specific site information in the sacred lands file does not indicate the absence of cultural resources in any project area. Other sources of cultural resources should also be contacted for information regarding known and recorded sites.

Enclosed is a list of Native Americans individuals/organizations who may have knowledge of cultural resources in the project area. The Commission makes no recommendation or preference of a single individual, or group over another. This list should provide a starting place in locating areas of potential adverse impact within the proposed project area. I suggest you contact all of those indicated, if they cannot supply information, they might recommend other with specific knowledge. If a response has not been received within two weeks of notification, the Commission requests that you follow-up with a telephone call to ensure that the project information has been received.

If you receive notification of change of addresses and phone numbers from any these individuals or groups, please notify me. With your assistance we are able to assure that our lists contain current information. If you have any questions or need additional information, please contact me at (916) 653-4038.

Sincerely,

Debbie Pilas-Treadway

Debbie Pilas-Treadway
Environmental Specialist III

NATIVE AMERICAN CONTACTS
San Mateo County
June 16, 2003

Trina Marine Ruano Family
Ramona Garibay, Representative
16101 5th Street
Lathrop , CA 95330
(510) 792-1642
(510) 673-5029 - Cell

Ohlone/Costanoan

This list is current only as of the date of this document.

Distribution of this list does not relieve any person of statutory responsibility as defined in Section 7050.5 of the Health and Safety Code, Section 5097.94 of the Public Resources Code and Section 5097.98 of the Public Resources Code.

This list is only applicable for contacting local Native Americans with regards to the cutural assessmet for the proposed South Bay Salt Ponds ISP project, San Mateo County.

NATIVE AMERICAN CONTACTS
Santa Clara County
June 16, 2003

Ella Rodriguez PO Box 1411 Salinas , CA 93902 (831) 632-0490 - home (831) 261-5827 - cell	Ohlone/Costanoan Esselen	Amah San Juan Band Marion Martinez 26206 Coleman Avenue Hayward , CA 94544 (510) 732-6806 - home comncompy@hotmail.com - email	Ohlone/Costanoa
Jakki Kehl 720 North 2nd Street Patterson , CA 95363 (209) 892-2436 (209) 892-2435 - Fax jakki@bigvalley.net	Ohlone/Costanoan	Amah/Mutsun Tribal Band Michelle Zimmer 4952 McCoy Avenue San Jose , CA 95130 (408) 378-7705	Ohlone/Costanoa
Katherine Erolinda Perez 1234 Luna Lane Stockton , CA 95206 (209) 462-2680	Ohlone/Costanoan Northern Valley Yokut Bay Miwok	Amah/MutsunTribal Band Irene Zwierlein, Chairperson 789 Canada Road Woodside , CA 94062 (650) 851-7747 - Home (650) 851-7489 - Fax (408) 364-1393 - Cell	Ohlone/Costanoa
Amah San Juan Band Charles Higuera 1316 Buena Vista Ave. Pacific Grove , CA 93950 (831) 375-9581 - work (831) 375-5045- home matuzwest@aol.com	Ohlone/Costanoan	Indian Canyon Mutsun Band of Costanoan Ann Marie Sayers, Chairperson P.O. Box 28 Hollister , CA 95024 (831) 637-4238	Ohlone/Costanoa

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This list is only applicable for contacting local Native Americans with regards to the cutural assessmet for the proposed South Bay Salt Ponds ISP project, Santa Clara County.

NATIVE AMERICAN CONTACTS
Santa Clara County
June 16, 2003

The Ohlone Indian Tribe
Andrew Galvan
PO Box 3152 Ohlone/Costanoan
Mission San Jose , CA 94539
(510) 656-0787 - Voice
(510) 882-0527 - Cell
(510) 656-0780 - Fax
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Thomas P. Soto
Howard S. Soto
P.O. Box 56802 Ohlone/Costanoan
Hayward , CA 94541
(530) 889-2444
sotoland@sbcglobal.net
(510) 733-6158 Fax
hs6001@aol.com

Trina Marine Ruano Family
Ramona Garibay, Representative
16101 5th Street Ohlone/Costanoan
Lathrop , CA 95330
(510) 792-1642
(510) 673-5029 - Cell

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NATIVE AMERICAN CONTACTS
San Mateo County
June 16, 2003

Ella Rodriguez PO Box 1411 Salinas , CA 93902 (831) 632-0490 - home (831) 261-5827 - cell	Ohlone/Costanoan Esselen	Amah/MutsunTribal Band Irene Zwierlein, Chairperson 789 Canada Road Woodside , CA 94062 (650) 851-7747 - Home (650) 851-7489 - Fax (408) 364-1393 - Cell	Ohlone/Costanoa
Jakki Kehl 720 North 2nd Street Patterson , CA 95363 (209) 892-2436 (209) 892-2435 - Fax jakki@bigvalley.net	Ohlone/Costanoan	Indian Canyon Mutsun Band of Costanoan Ann Marie Sayers, Chairperson P.O. Box 28 Hollister , CA 95024 (831) 637-4238	Ohlone/Costanoa
Katherine Erolinda Perez 1234 Luna Lane Stockton , CA 95206 (209) 462-2680	Ohlone/Costanoan Northern Valley Yokut Bay Miwok	The Ohlone Indian Tribe Andrew Galvan PO Box 3152 Mission San Jose , CA 94539 (510) 656-0787 - Voice (510) 882-0527 - Cell (510) 656-0780 - Fax chochenyo@AOL.com	Ohlone/Costanoa
Amah/Mutsun Tribal Band Michelle Zimmer 4952 McCoy Avenue San Jose , CA 95130 (408) 378-7705	Ohlone/Costanoan	Thomas P. Soto Howard S. Soto P.O. Box 56802 Hayward , CA 94541 (530) 889-2444 sotoland@sbcglobal.net (510) 733-6158 Fax hss001@aol.com	Ohlone/Costanoa

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This list is only applicable for contacting local Native Americans with regards to the cutural assessmet for the proposed South Bay Salt Ponds ISP project, San Mateo County.

Additional Sediment Sampling and Analysis Plan

South Bay Salt Ponds Initial Stewardship Plan

Prepared by Lisa R. Stallings, Life Science!, Inc.

1.0 Introduction

In preparation of the initial Report of Waste Discharge (ROWD) for the South Bay Salt Ponds Initial Stewardship Project (ISP) sediment data was collected from several sources: sediment samples collected and analyzed from various project areas for the ROWD, data previously collected by the US Fish and Wildlife Service from the project sites, and data collected from adjacent properties for other projects. There is some uncertainty with several data sets, as essential sampling and analytical method information was not available. Trends in the data suggest that mercury and selenium may be elevated in some ponds, but the extent of the problem cannot be determined by this data set alone. The Regional Water Quality Control Board (RWQCB) staff, upon review of the ROWD, recommended that additional sampling be undertaken to delineate the nature and extent of mercury and selenium contamination. Additionally, during the ISP, the ponds will be managed, to the extent possible, in a manner that minimizes methylation of mercury in sediments. The DFG and FWS will need baseline information about total mercury and methyl-mercury levels to adaptively mange the ponds.

There is little indication that contaminants are elevated at either the Baumberg or the West Bay Complexes. But this statement is based on only three samples from the Baumberg Complex and one sample from the West Bay Complex. Additional sampling will be performed at both complexes to confirm the status of contaminants at these sites.

This sampling analysis plan (SAP) describes the procedures and rationale for the collecting of samples and submittal of these samples for chemical and physical analysis. The purpose of this SAP is to describe the sample locations, sample collection procedures, and analyses to be performed.

The sampling plan will involve discrete sediment sampling at three locations and two depths in each of the selected ponds. Part of each sample will be archived for future analysis should it be useful. Specific ponds for inclusion in this SAP were selected on the basis of pond function (e.g.outfall), location, lack of existing of data, and anticipated changes in management regime. For example, ponds for which there is a proposed change in water regimes, have little available data on mercury levels, and are located in an area of known contamination were chosen for characterization. Ponds with mercury greater than 0.35 mg kg^{-1}, previous and proposed sampling points are shown in Figures 1, 2, and 3.

2.0 Sampling Locations

Samples will be taken in 16 ponds at a total of 50 sampling locations. Figures 1, 2, and 3 present the general location of these sample points. Table 1 identifies the ponds and type of analysis to be performed at each sample location.

Alviso Complex
Pond A3N was chosen for sampling due to its position (adjacent to a pond with elevated mercury) and changing water levels (may be managed as a seasonal pond). Pond A2E was chosen due to the elevated Hg levels in tissues detected by the FWS. Ponds A7, A11, A12, A13, and A14 were chosen for sampling due to their positions (adjacent to ponds with elevated mercury levels) and lack of data. Pond A8 was chosen for five sampling sites due to its position (adjacent to Alviso Slough), changing water levels (portions of it may be allowed to dry out), use by special status species (Snowy Plover nesting site), and lack of useful data. Pond A23 was chosen due to the recent presence of Snowy Plover nesting sites and lack of data in this area.

Baumberg Complex
Ponds 2, 6A, 11, and 12 were chosen for sampling to give a reasonable spatial distribution of sampling points and their function (all outfalls will be sampled).

West Bay Complex
Ponds 2, 3, and 4 were chosen for sampling to give a reasonable spatial distribution of sampling points and their function (all outfalls sampled).

Table 1. Summary of Samples to be Collected.

Pond Number	**Locations**	**Constituents to Be Analyzed**			
Alviso Complex		Hg	MeHg	Se and Arsenic???	Metals
A3N	3	X	X	X	
A3E	3	X	X	X	
A7	3	X	X	X	
A8	5	X	X	X	
A11	3	X	X	X	
A12	3	X	X	X	
A13	3	X	X	X	
A14	3	X	X	X	
A23	3	X	X	X	
Sub-total	*29*				
Baumberg Complex					
2	3	X	X		X
6A	3	X	X		X
11	3				X
12	3				X
Sub-total	*12*				
West Bay Complex					
2	3	X	X		X
3	3				X
4	3				X
Sub-total	*9*				
Total	***50***	38	38	29	21

Notes: All sampling locations will be sampled at the surface and at depth.
All samples will be analyzed for salinity and pH. Additionally, Hg and MeHg samples will be analyzed for total organic carbon.

3.0 Sediment Sampling

Sample Collection
Sediment Samples will be collected from the bottom of ponds with a 2-1/4” diameter AMS sediment sludge sampler near the shore water interface. Six samples will be submitted for analysis from each pond, three from the surface (0–2 inches) and the other three at depth (6–8 inches). Figures 1, 2, and 3 present the sample station of each sub-sample (at both depths). Upon completion of each sample collection, the sediment sample will be directly placed in an ice chest and cooled to 4*C.

4.0 Sample Analysis

As shown in Table 1, a total of 50 locations at two depths are proposed for sediment sample collection at the three Complexes that make up the ISP (total of 100 samples). The sediment samples will be analyzed for the parameters as listed in Table 1. Selenium and Arsenic will be analyzed using atomic adsorption spectroscopy (graphite furnace, methods 7740 and 7060, respectively) not by ICP. Sediment samples will analyzed for metals by EPA Method 6010/6020, mercury by EPA method 7471, and methyl-mercury by cold vapor atomic florescence spectrophotometry detection. All samples will be analyzed for salinity and pH (method 9045). Additionally, samples analyzed for mercury/methyl-mercury will be analyzed for total organic carbon (weight loss on ignition) (method 9060).

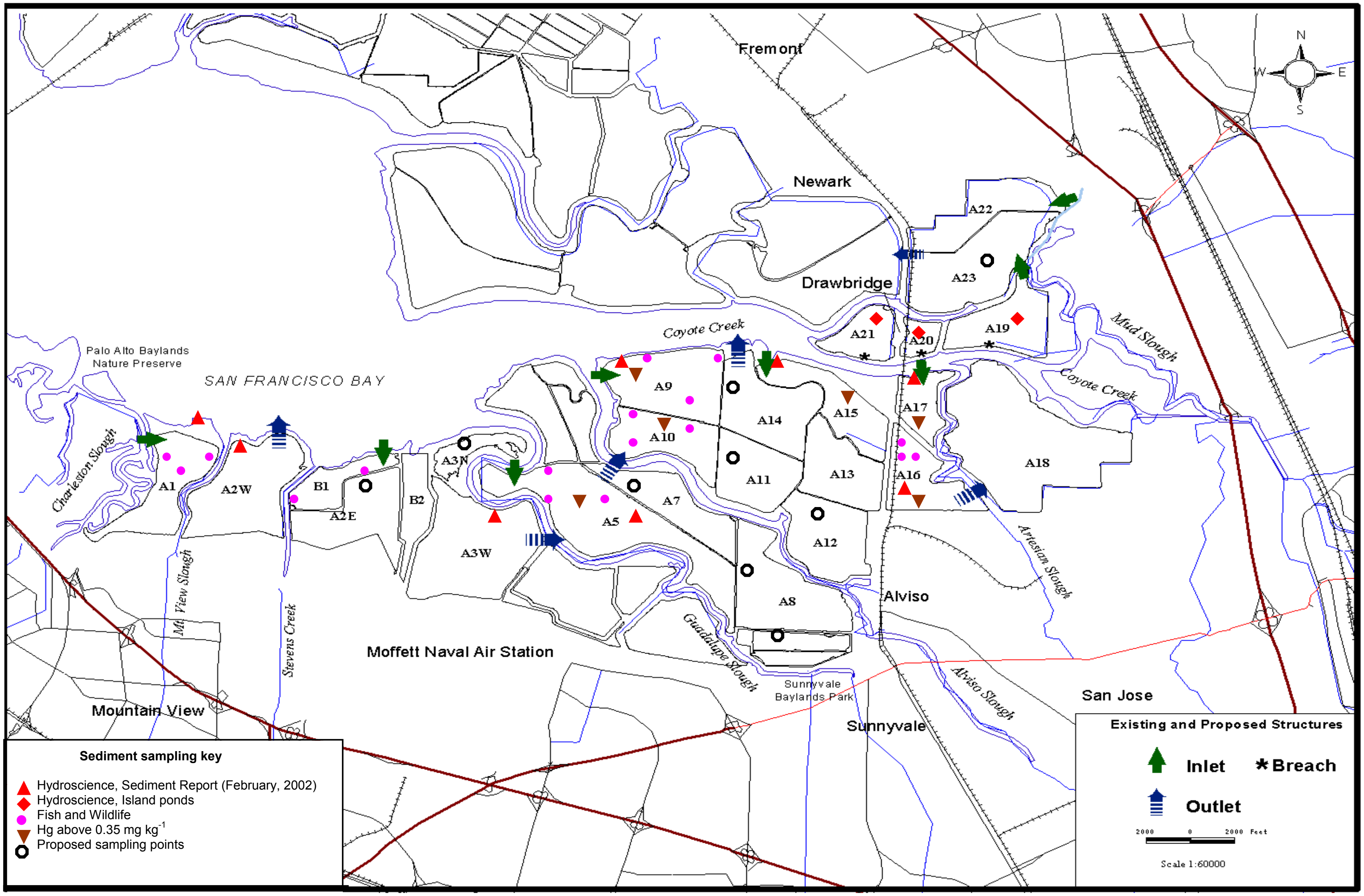


Figure 1. Previous and proposed sediment sample locations within the Alviso Complex.

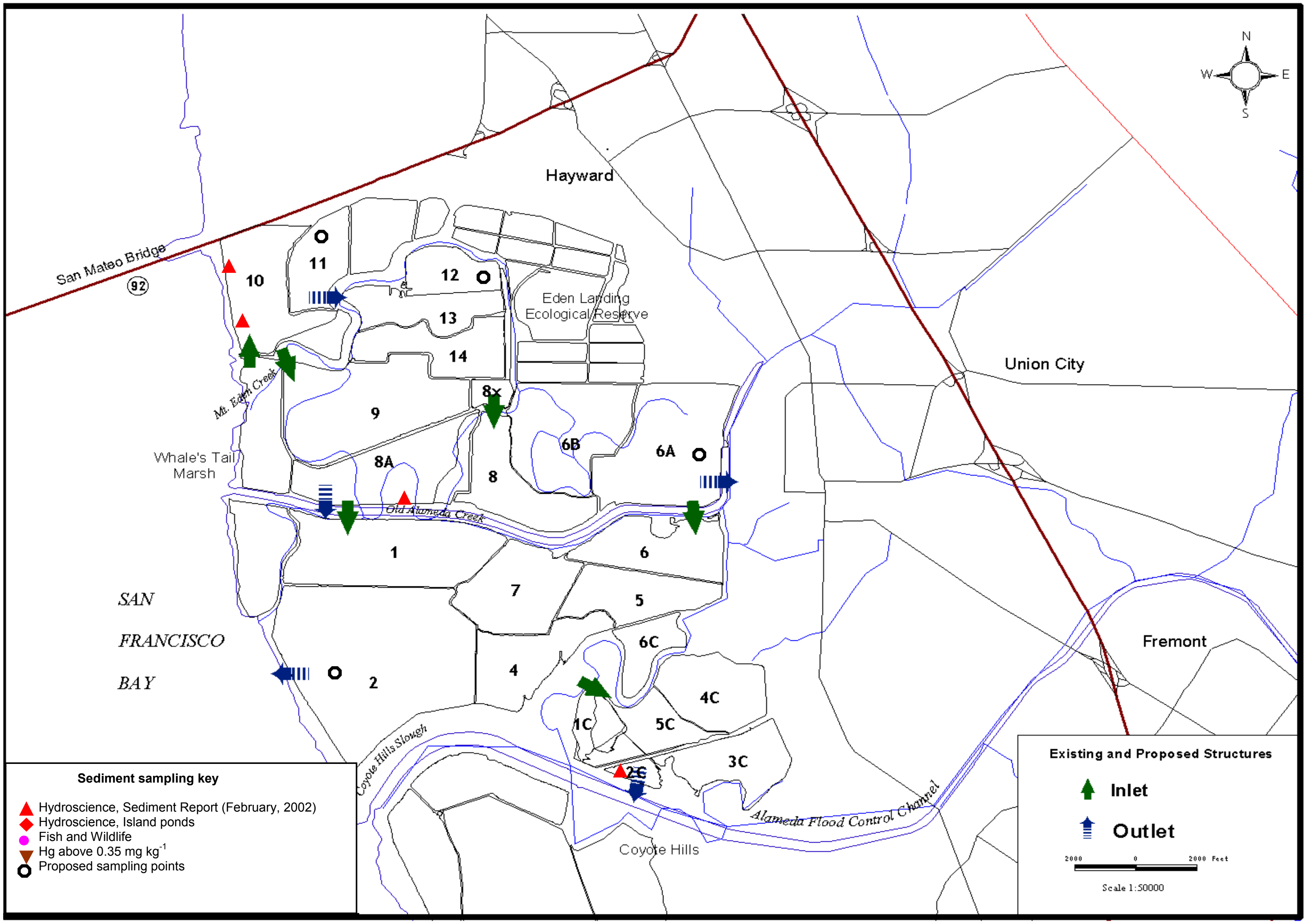


Figure 2. Previous and proposed sediment sample locations within the Baumberg Complex.

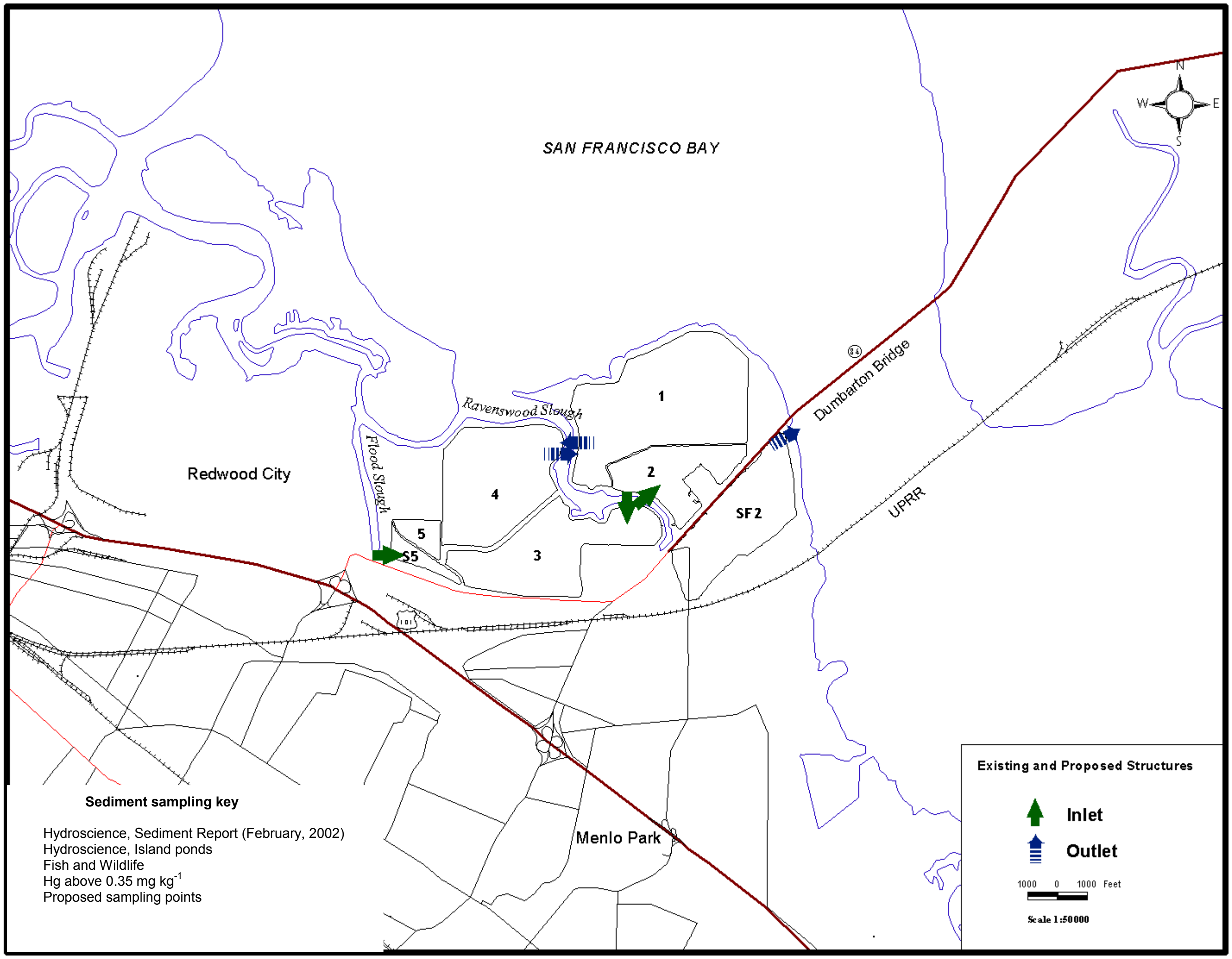


Figure 3. Previous and proposed sediment sampling locations within the West Bay Complex.

Appendix J

Selected Tables and Figures from PRBO Report to California Coastal Conservancy

(Stralberg et al. 2003)

Stralaberg, D., N. Warnock, N. Nur, H. Spautz, and G. Page. 2003. Predicting the effects of habitat changes on South San Francisco Bay bird communities: An analysis of bird-habitat relationships and potential restoration scenarios. Habitat Conversion Model: Phase One, PRBO Conservation Science, Stinson Beach, CA.

TABLES AND FIGURES

Table 1. **Summary of South San Francisco Bay salt ponds surveyed between October 1999 and April 2001. Data from Siegel and Bachand (2002).**

Pond Number	Complex	Owner	Salinity Range*	Elevation (feet)	Hydrology / Setting**	Restoration Feasibility**	Comments
10	Baumberg	CDFG	low	2 to 3	open bay edge, no marsh	med-high	intake pond
11	Baumberg	CDFG	low	3 to 4	tributary channel, marsh	low-med	
12/13	Baumberg	CDFG	low	2 to 4	tributary channel, marsh	low-med	
14	Baumberg	CDFG	low	3 to 4	tributary channel, marsh	low-med	
6A	Baumberg	CDFG	low	1 to 2	tributary channel, marsh	medium	
8A	Baumberg	CDFG	low	3 to 4	tributary channel, marsh	low	
9	Baumberg	CDFG	low	2 to 3	tributary channel, marsh	medium	
A11	Alviso	USFWS	low	-2 to-1	tributary channel, marsh	medium	
A14	Alviso	USFWS	low	-1 to 0	open bay edge, marsh	medium	
A16	Alviso	USFWS	low-medium	0 to 1	tributary channel, marsh	medium	
A4	Alviso	SCVWD	low	2 to 3	tributary channel, marsh		
A9	Alviso	USFWS	low	0 to 1	open bay edge, marsh	medium	intake pond
N1A	Newark	Cargill	medium	3 to 4	tributary channel, marsh	med-high	intake pond
N3	Newark	Cargill	medium-high	2 to 3	open bay edge, no marsh	medium	
N3W	Newark	Cargill	medium-high	2 to 3	open bay edge, no marsh	medium	
N4	Newark	Cargill	medium	2 to 3	open bay edge, no marsh	med-high	
N6	Newark	Cargill	medium	3 to 4	no tidal edge	medium	
N9	Newark	Cargill	medium	2 to 3	no tidal edge	medium	
PP1	Newark	Cargill	medium-high	3 to 4	tributary channel, marsh	medium	
R2	Redwood City	USFWS	medium-high	1 to 2	tributary channel, marsh	high	
SF2	Redwood City	USFWS	medium	2 to 3	open bay edge, marsh	medium	

* low salinity = 20-60 ppt; medium salinity = 60-120 ppt; high salinity = 120+ ppt.

** restoration feasibility ratings (Siegel and Bachand 2002) were based on a combination of physical (e.g., elevation, proximity to tides and sediment source), biological, chemical and economic criteria.

Table 2. Summary of South San Francisco Bay salt pond survey site characteristics used in regression analyses. Salinity values were modeled on a per-survey basis. See Table 1 for pond complex names.

Pond Number	Survey Area Size (ha)	Mean (± SD) 1999-2000 Salinity (ppt)	N (1999-2000)	Mean (±SD) 2000-2001 Salinity (ppt)	N (2000-2001)
10	105.3	--	0	32 (±4)	8
11	49.0	--	0	38 (±9)	32
12/13	98.3	--	0	49 (±7)	64
14	64.9	--	0	65 (±12)	8
6A	133.1	--	0	70 (±7)	8
8A	109.1	--	0	127 (±31)	32
9	150.7	--	0	101 (±20)	32
A11	108.5	--	0	59 (±10)	4
A14	142.0	--	0	79 (±11)	30
A16	97.3	--	0	69 (±6)	31
A4	124.0	--	0	38 (±4)	31
A9	150.4	--	0	25 (±2)	30
N1A	70.1	58 (±5)	12	69 (±4)	32
N3	58.0	--	0	208 (±20)	8
N3W	116.6	166 (±13)	10	--	0
N4	137.4	79 (±9)	12	144 (±11)	32
N6	38.0	59 (±3)	12	110 (±6)	32
N9	55.4	56 (±2)	12	104 (±7)	26
PP1	39.5	201 (±24)	12	259 (±5)	32
R2	57.2	228 (±38)	12	--	0
SF2	97.5	197 (±24)	12	253 (±16)	30

Table 8. Salt pond species diversity metrics by site for South San Francisco Bay salt ponds surveyed between October 1999 and April 2001.*

Pond	Number of Area Surveys	Species Richness	Shannon Diversity Index
10	8	51	7.24
11	32	51	4.90
12/13	32	56	6.96
14	8	38	4.48
6A	8	56	4.81
8A	32	50	7.24
9	32	46	3.82
A11	4	23	4.31
A14	30	44	8.08
A16	31	47	7.39
A4	31	66	8.76
A9	30	56	7.24
N1A	44	62	13.20
N3	8	38	6.49
N4	44	54	9.03
N6	44	41	2.12
N9	38	53	4.48
PP1	44	47	6.96
R2	12	13	4.85
SF2	42	49	8.25
Mean	27.70	47.05	6.53
Std.Error	3.18	2.76	0.54

* Pond N3W, a subset of pond N3, not included.

Table 10. Mean densities (birds per hectare per survey) for the 40 most abundant species (not including landbirds other than corvids and swallows) in South San Francisco Bay tidal marshes (N = 214 surveys) and salt ponds (N = 585 surveys), surveyed between October 1999 and April 2001. Species among 40 most abundant in both habitats are indicated in unique colors.

Tidal Marsh Species	Mean	Std. Dev.	Max	Salt Pond Species	Mean	Std. Dev.	Max
NSHO	0.605	1.783	16.23	DUNL	6.90	[illegible]	[illegible]
				WESA	6.44	26.24	327.35
MALL	0.434	0.954	8.50	NSHO	6.05	18.56	181.40
WESA	0.317	2.359	23.75	AMAV	2.17	6.63	62.83
GWTE	0.241	0.897	8.21	EAGR	1.48	3.21	24.90
AMCO	0.213	0.786	6.02	WILL	1.46	4.32	31.94
DOWI	0.205	0.919	8.45	BBPL	1.23	4.79	46.62
WILL	0.130	0.893	11.92	RUDU	1.01	2.47	20.89
AMWI	0.125	0.323	2.10	BNST	0.959	2.57	19.82
BNST	0.100	0.411	3.63	DOWI	0.866	4.29	52.35
RUDU	0.084	0.290	2.06	CAGU	0.716	2.53	[illegible]
HERG	0.080	0.828	9.82	BOGU	0.698	2.67	28.42
GADW	0.066	0.186	1.21	MAGO	0.687	2.82	23.99
NOPI	0.062	0.320	2.67				
[illegible]	[illegible]	[illegible]	[illegible]	BUFF	0.250	0.892	9.97
CANV	0.051	0.215	1.78	AMWI	0.187	1.213	16.42
GRYE	0.051	0.145	1.67	SEPL	0.169	1.159	22.03
CITE	0.047	0.216	2.14	NOPI	0.162	1.518	29.53
CAGO	0.044	0.226	2.81	CANV	0.142	0.872	11.70
SNEG	0.032	0.067	0.40	LESC	0.074	0.366	5.51
CLSW	0.032	0.379	5.36	FOTE	0.070	0.292	3.20
VGSW	0.030	0.442	6.46	RBGU	0.067	0.293	4.33
AMAV	0.025	0.100	0.88	WEGU	0.066	0.816	18.87
KILL	0.025	0.092	0.65	DCCO	0.064	0.322	4.63
CLRA	0.021	0.059	0.44	AMCO	0.062	0.388	6.30
BARS	0.020	0.108	1.05	REKN	0.060	0.522	8.94
LBCU	[illegible]	[illegible]	[illegible]	AWPE	0.054	0.369	5.47
NOHA	0.016	0.032	0.214	GRSC	0.049	0.183	1.85
WTKI	0.015	0.027	0.116	SNPL	0.042	0.225	3.12
GREG	0.013	0.030	0.250	MEGU	0.032	0.209	3.60
SEPL	0.012	0.093	1.11	PBGR	0.029	0.132	1.89
GBHE	0.005	0.016	0.102	GADW	0.027	0.155	2.08
RTHA	0.005	0.016	0.105	COGO	0.027	0.198	4.00
CAGU	0.004	0.036	0.484	THGU	0.026	0.445	10.67
PBGR	0.004	0.016	0.100	WEGR	0.022	0.074	0.510
WEGR	0.004	0.022	0.233	SNEG	0.022	0.065	0.680
CORA	0.003	0.020	0.210	RBME	0.018	0.071	0.740
BCNH	0.003	0.015	0.097	GREG	0.018	0.072	0.910
BBPL	0.003	0.022	0.194	SAND	0.018	0.091	1.19
SEOW	0.003	0.017	0.192	LBCU	0.017	[illegible]	[illegible]

Table 11. Classification of core salinity ranges for 50* most abundant waterbird species detected in South Bay salt ponds between October and April, 1999/2000 and 2000/2001 (feeding detections only). Core salinity ranges represent the values between 25^{th} and 75^{th} percentiles; i.e., at least 50% of detections were within the given salinity range.

0-60 ppt	60-120 ppt	120-180 ppt	180+ ppt
American Coot			
Green-winged Teal			
Gadwall			
Northern Pintail			
American Wigeon			
Red-breasted Merganser			
American White Pelican			
Pied-billed Grebe			
Canvasback			
Double-crested Cormorant			
Forster's Tern			
Marbled Godwit			
Red Knot			
Black-crowned Night Heron			
Great Egret			
Snowy Egret			
Western Grebe			
Glaucous-winged Gull			
Canada Goose	Canada Goose		
Northern Shoveler	Northern Shoveler		
Clark's Grebe	Clark's Grebe		
Common Goldeneye	Common Goldeneye		
Ruddy Duck	Ruddy Duck		
Mallard	Mallard		
Black-bellied Plover	Black-bellied Plover		
Long-billed Curlew	Long-billed Curlew		
Dowitcher	Dowitcher		
Semipalmated Plover	Semipalmated Plover		
Western Gull	Western Gull		
Bufflehead	Bufflehead		
Greater Yellowlegs	Greater Yellowlegs		
Ring-billed Gull	Ring-billed Gull	Ring-billed Gull	
Killdeer	Killdeer	Killdeer	
Snowy Plover	Snowy Plover	Snowy Plover	
	Bonaparte's Gull		
	Mew Gull		
	Lesser / Greater Scaup	Lesser / Greater Scaup	
	Red-necked Phalarope	Red-necked Phalarope	
	Eared Grebe	Eared Grebe	
	American Avocet	American Avocet	
	Sanderling	Sanderling	
	Black-necked Stilt	Black-necked Stilt	
	Ruddy Turnstone	Ruddy Turnstone	
	Willet	Willet	
	Dunlin	Dunlin	
	Least Sandpiper	Least Sandpiper	
	Western Sandpiper	Western Sandpiper	Western Sandpiper
	California Gull	California Gull	California Gull

* Lesser and Greater Scaup were combined in this analysis. Thayer's Gull was not included due to lack of feeding detections.

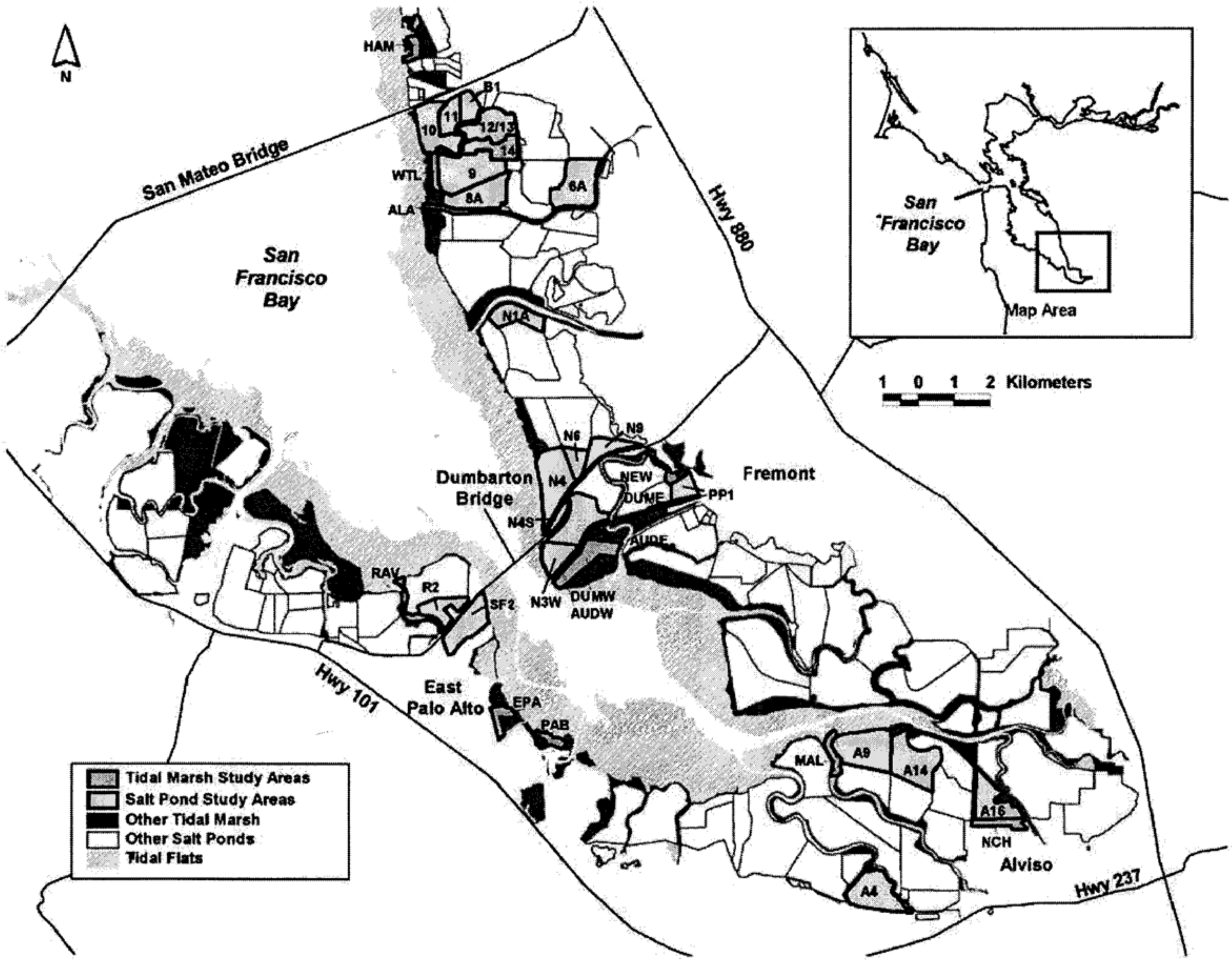


Figure 1. Map of salt ponds and tidal marshes surveyed in south San Francisco Bay, CA from 1999-2001.

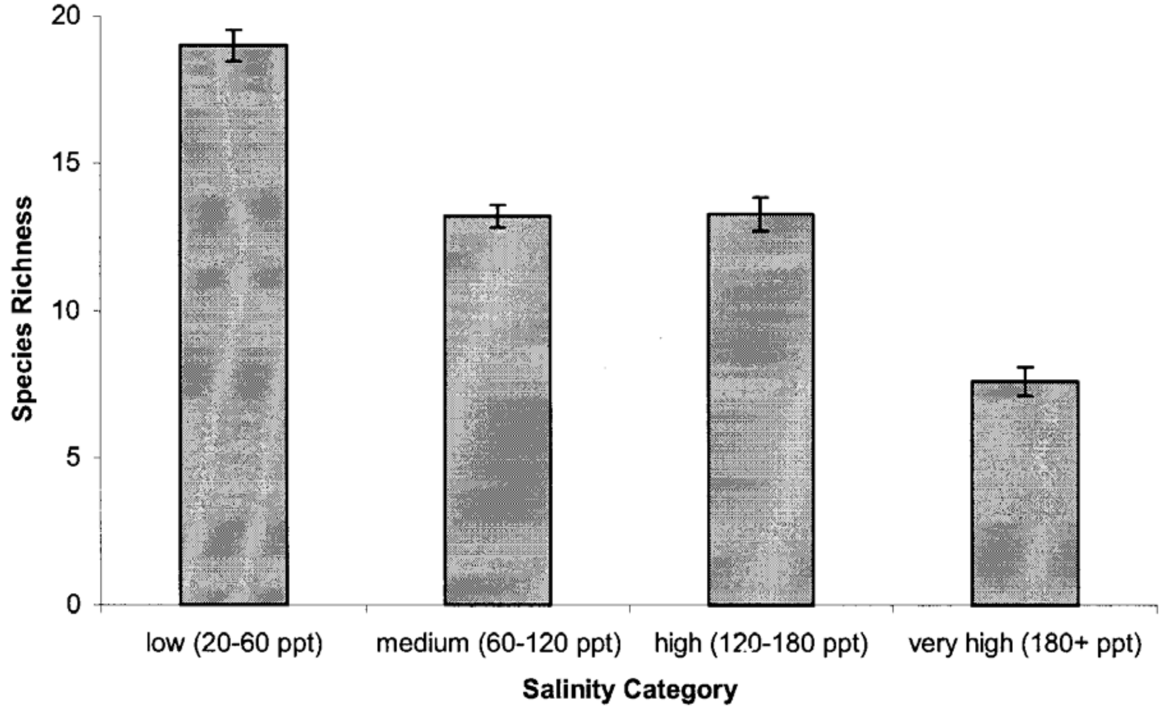


Figure 15. Species richness by salt pond salinity category for South San Francisco Bay salt ponds surveyed in 1999/00 and 2000/01. Error bars represent standard errors of the mean for each salinity category.

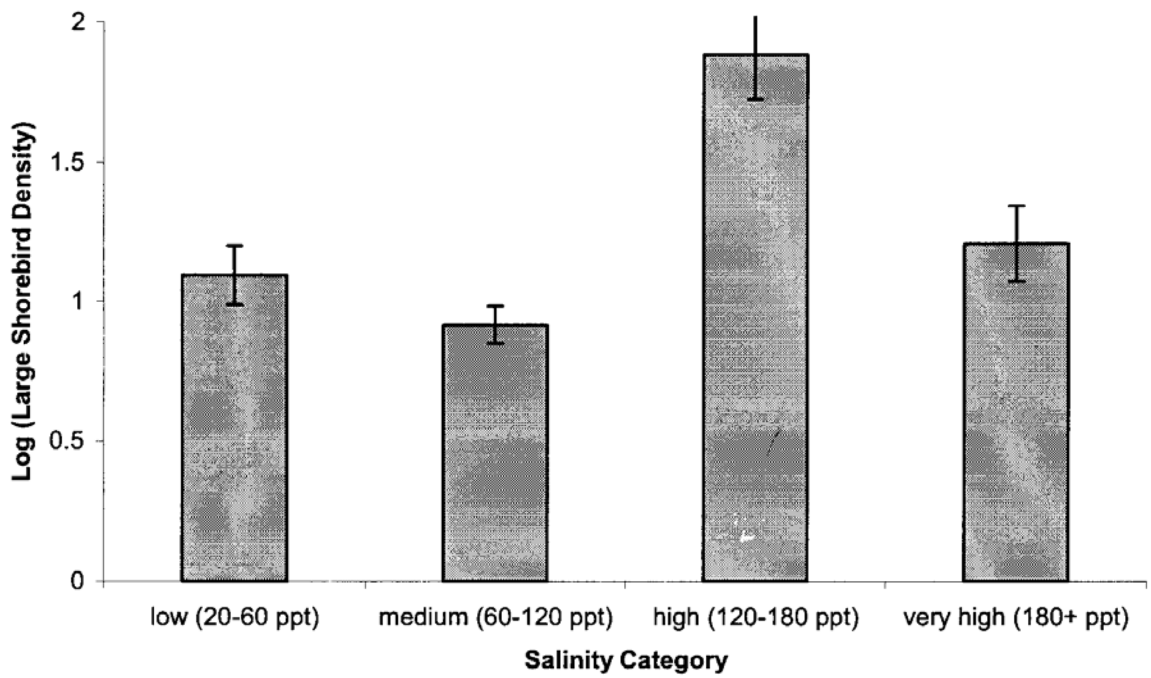


Figure 16. Mean log-transformed large shorebird density by salt pond salinity category for South San Francisco Bay salt ponds surveyed in 1999/00 and 2000/01. Error bars represent standard errors of the mean for each salinity category.

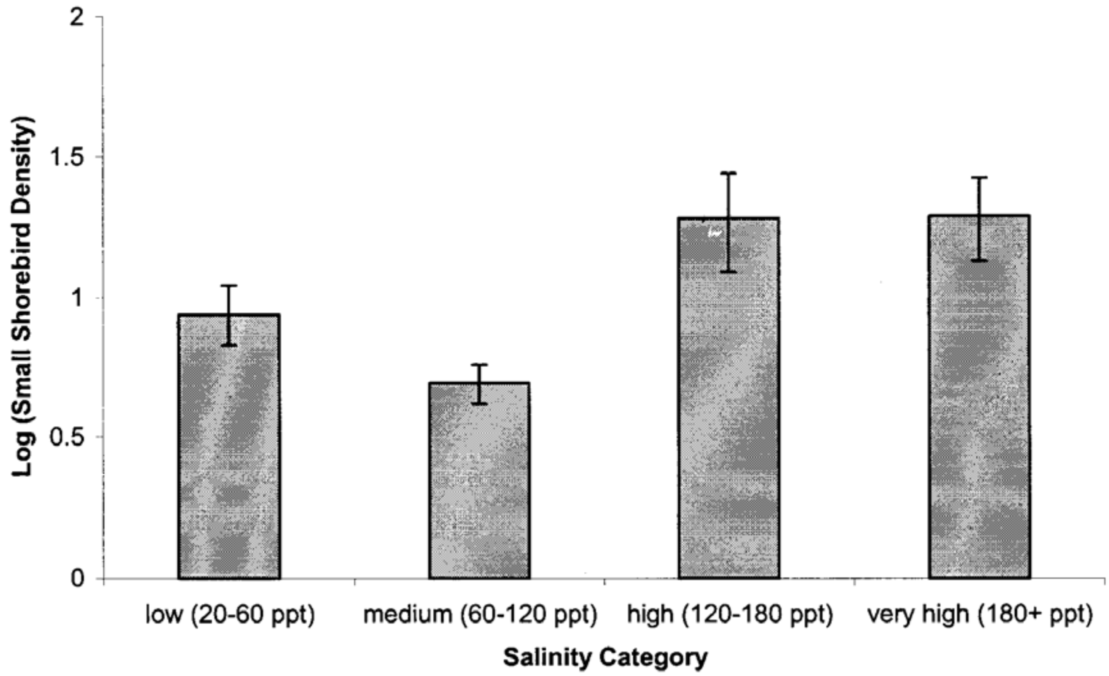


Figure 17. Mean log-transformed small shorebird density by salt pond salinity category for South San Francisco Bay salt ponds surveyed in 1999/00 and 2000/01. Error bars represent standard errors of the mean for each salinity category.

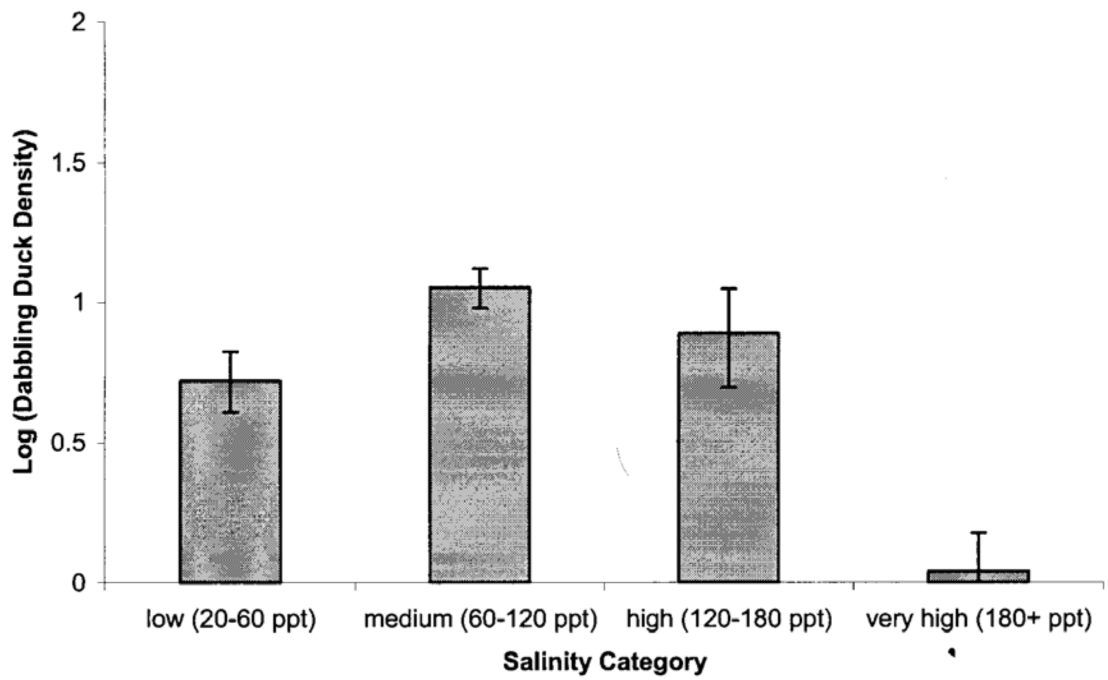


Figure 18. Mean log-transformed dabbling duck density by salt pond salinity category for South San Francisco Bay salt ponds surveyed in 1999/00 and 2000/01. Error bars represent standard errors of the mean for each salinity category.

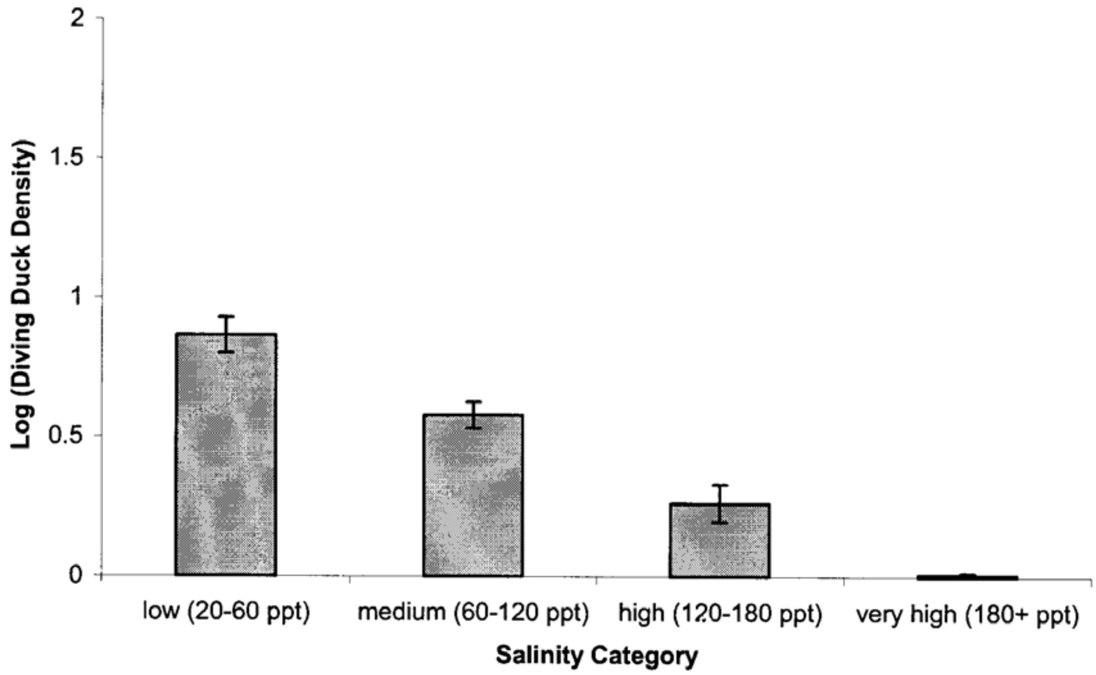


Figure 19. Mean log-transformed diving duck density by salt pond salinity category for South San Francisco Bay salt ponds surveyed in 1999/00 and 2000/01. Error bars represent standard errors of the mean for each salinity category.

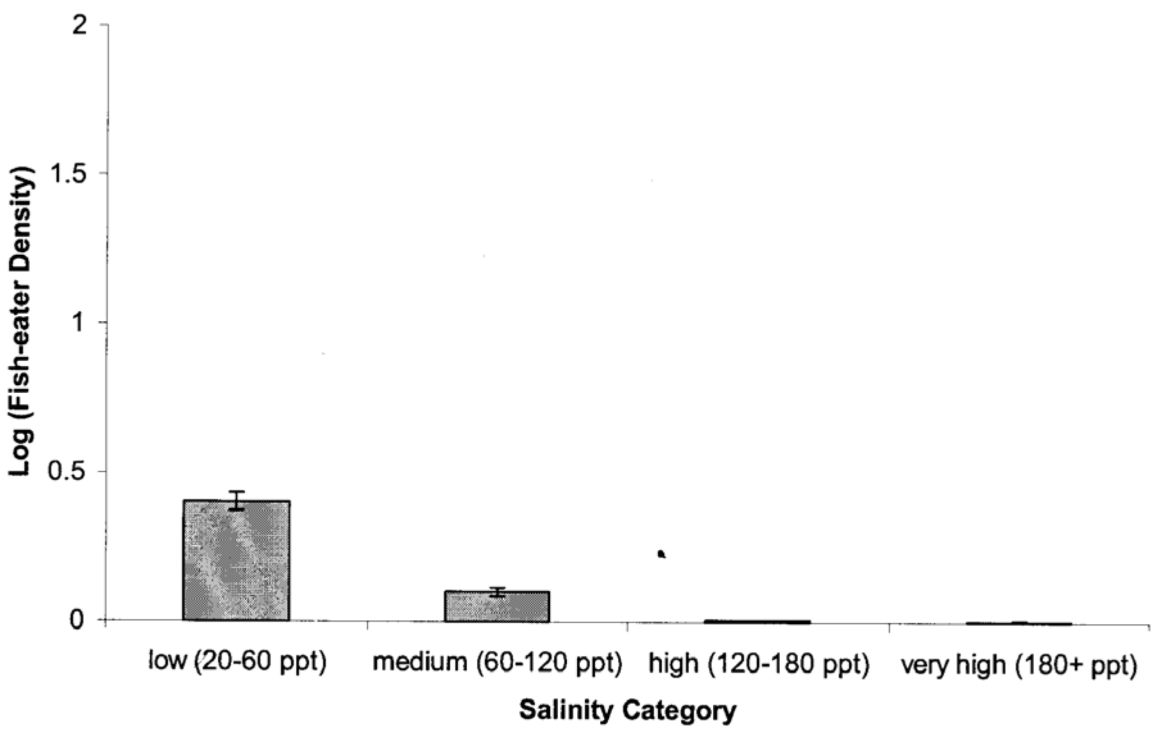
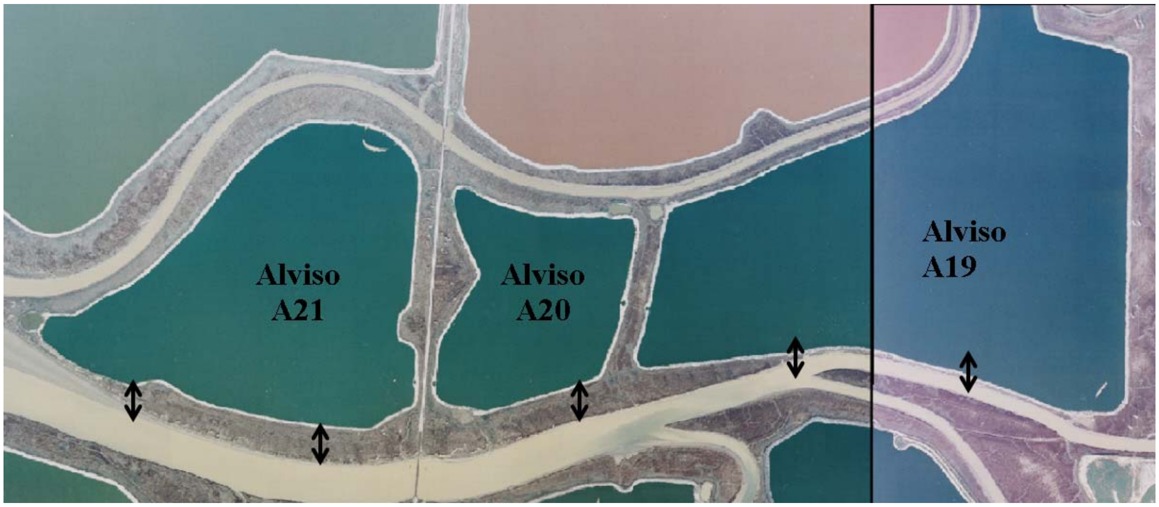


Figure 20. Mean log-transformed fish-eater density by salt pond salinity category for South San Francisco Bay salt ponds surveyed in 1999/00 and 2000/01. Error bars represent standard errors of the mean for each salinity category.

ALVISO ISLAND POND BREACH INITIAL STEWARDSHIP PLAN STUDY



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September 2003

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1. Introduction

The Alviso island ponds, Alviso A19, A20 and A21, are located between Coyote Creek and Mud Slough, as shown in Figure 1-1. The preferred management alternative for the Alviso island ponds is to breach the levees and establish full tidal circulation in each pond. The island ponds are particularly good candidates to breach for several reasons. The relatively high bottom elevations in the ponds mean that the ponds are likely to provide good tidal marsh habitat. Due to their location the island ponds are less accessible than other ponds, which makes them a good choice for breaching. Under this management alternative there would be no hydraulic connection between the island ponds and, therefore, each pond would operate independently. No active management and maintenance would be required.

The island pond levees bordering Coyote Creek would be breached at locations chosen based on the following objectives:

1) Minimize marsh impacts in Coyote Creek;
2) Limit potential for scour near the Union Pacific Railroad bridge;
3) Locate the breaches near historic/remnant marsh channels in the island ponds.

The breach locations selected based on these criteria are shown in Figure 1-2.

Breaching the island ponds may result in changes in the Alviso Region. Potential effects of breaching the island ponds include changes to salinity, tidal hydrodynamics and channel morphology (cross-sectional geometry) in the Alviso Region. Effects on tidal hydrodynamics include changes in tidal elevations (e.g., MHHW), changes in tidal prism, and changes in tidal velocities. The purpose of this study is to make conservative predictions of the potential effects of the levee breaches. The predictions are considered conservative because, due to the assumptions made in the study, they are more likely to overestimate effects in the Alviso Region (e.g., salinity increases) than they are to underestimate the effects that may result from the levee breaches.

Prior to discharge much of the volume in the island ponds will be transferred to Cargill plant 2. After the brine in the ponds is removed less saline water will be circulated through them. Upon discharge the ponds will contain a limited volume of brine, largely contained in the borrow ditches, and will be at a salinity of 135 ppt or less.

The proposed breaches would initially be shallow. The construction of shallow breaches will restrict flow through the breaches, thereby allowing the brine in the ponds to be mixed gradually into Coyote Creek. Over time the breaches are expected to erode, becoming both deeper and wider than the constructed breaches. During this period it is also likely that sediment will deposit in the island ponds and that they will approach marshplain elevation. Therefore, the largest possible changes in tidal hydrodynamics would occur if the breaches erode to a large area, allowing the island ponds to experience a full tidal range, while the pond bottom elevation remains relatively stable. Based on observations in Warm Springs Marsh (Williams et al., 2002), it is more likely that the breaches will erode slowly and that considerable deposition will occur in the island ponds before the breach geometry reaches an equilibrium morphology. This more realistic evolution would result in smaller changes in the hydrodynamics of Coyote Creek than those estimated in this study.

The largest effects on salinity are likely to occur at a different period in time than the largest effects on tidal hydrodynamics and channel morphology. The largest salinity effects are expected to occur following the construction of the levee breaches when the brine initially in the pond is mixed into Coyote Creek. This period of approximately one month following opening the levee breaches will be referred to as the "initial breach period." The largest changes in hydrodynamics in the Alviso Region are expected to occur later, during the "long term period," when the breaches erode down to the bottom elevation of the island pond borrow ditches. At this point, the island ponds would drain freely into Coyote Creek at low water and would experience a similar tidal range as the tidal range experienced in Coyote Creek. Therefore, the tidal prism into the island ponds would be approximately equal to the maximum possible tidal prism, resulting in the largest possible changes in Coyote Creek hydrodynamics.

The primary tool used in the study of the potential effects of the island pond levee breaches is the three-dimensional TRIM model. The model was calibrated using a large set of tidal elevation, tidal velocity and salinity data. The model is described in Section 3 and the model calibration is described in Section MCV.2.

2. Environmental Setting

The Alviso island ponds range in size from 63 to 265 acres and have relatively high bottom elevations (average bottom elevation ranges from 1.8 to 2.3 feet NGVD) compared with other ponds in the Alviso complex. The borrow ditches which inscribe each pond are typically 4 to 8 feet below the pond bottom elevation.

The island ponds are part of the Alviso Complex, located in the Lower South Bay. The Lower South Bay is defined as the portion of SSFB location landward (south) of the Dumbarton Bridge. Lower South Bay is a relatively shallow subembayment with an average depth of 2.6 m at mean tide. Tides in this region are particularly strong due to amplification of tidal energy with distance landward in South San Francisco Bay. Both the diurnal inequality of the tides and the spring-neap cycle are clear in Figure 2-1, which shows two weeks of observed tides at NOAA station 9414509, located at the Dumbarton Bridge. Because of the strong tides and small depths, "the area covered by water in Lower South Bay at mean lower low water (MLLW) is less than half the surface area at mean higher high water (MHHW) indicating that over half of Lower South Bay consists of shallow mudflats that are exposed at low tides" (Schemel, 1998). Furthermore the volume of water in Lower South Bay at MLLW is less than half of the volume of water at MHHW, indicating that more than half of the water volume present in Lower South Bay at high water can pass through the Dumbarton Bridge during a single ebb tide (Schemel, 1998).

Near bottom salinity measured continuously by the USGS at the Dumbarton Bridge from 1995 to 1998 was highly correlated with freshwater flows and varied from approximately

5 ppt to 32 ppt (Schemel, 1998), as shown in Figure 2-2. The daily range of measured salinity at the Dumbarton Bridge can also be large, particularly during winter and spring, as shown in Figure 2-3.

The tidal sloughs that border the island ponds are Coyote Creek, Mud Slough and Artesian Slough. The largest tidal slough is Coyote Creek which meets SSFB at Calaveras Point. Coyote Creek is a noteable source of freshwater during winter and spring. Salt marsh regions are present in several parts of Coyote Creek, particularly bordering salt ponds. The bottom elevation of the main channel of Coyote Creek ranges from -1 to -4 m NGVD. The mean tidal range in Coyote Creek, reported as 2.2 m at NOAA Station 9414575 (NOAA, 2003), is particularly large.

Artesian Slough borders ponds Alviso A16 and Alviso A17 and is a tributary to Coyote Creek. The discharge from the City of San Jose municipal wastewater treatment plant enters the upstream end of Artesian Slough with a typical flow of approximately 130 mgd. For this reason, Artesian Slough generally has relatively low salinity (Kinnetic Labs, 1987).

Strong salinity gradients are present in both Coyote Creek and Artesian Slough (Kinnetic Labs, 1987) and frequently result in vertical salinity stratification (Simons, 2000). The daily range of salinity in Coyote Creek can be quite large. In a one week duration dataset collected in late January and early February 2000, the daily salinity range was typically 3 ppt to over 20 ppt (Simons, 2000), as shown in Figure 2-4. Salinity is also highly variable seasonally, with lower salinity during winter and spring, in Coyote Creek and Artesian Slough (Kinnetic Labs, 1987).

At the western end of pond Alviso A21, Mud Slough splits off from Coyote Creek and, bordering ponds Alviso A21, A20 and A19, continues landward to connect with the Warm Springs marsh restoration area. Mud Slough is a shallow tidal slough which receives minimal freshwater input during all seasons.

3. The TRIM Hydrodynamic Model

The three-dimensional TRIM (Tidal, Residual, Intertidal & Mudflat) model (Casulli, 1990; Casulli & Cattani, 1994) is a well-established tool for long term simulation of hydrodynamics in estuaries that include intertidal regions. Because this model is particularly well-suited to model SSFB and due to the success of previous modeling of hydrodynamics (Cheng et al., 1993) and salinity (Gross et al., 1999b) of South San Francisco Bay, the TRIM model was selected in this study. The advantage of using a three-dimensional model, as opposed to a depth-averaged model, is that a three-dimensional model can represent the vertical variability in salinity and velocity. This allows a three-dimensional model to more reliably predict long term transport of salt.

Several processes are represented in the TRIM model. Water in SSFB is in motion due to external forcing including tidal forcing, wind forcing and freshwater forcing. The velocities are strongly affected by bottom friction. Sources and sinks of water volume to the model include water entering through the boundary near the Oakland Bay Bridge, freshwater entering SSFB from creeks and rivers, inflows from wastewater treatment plants, evaporation and rain over the area of SSFB. Similarly, predicted salinity is influenced by exchange of water between Central Bay and South Bay (through the boundary of the SSFB model), freshwater inflows, which decrease the salinity, and evaporation, which increases salinity. During Initial Stewardship the model also accounts for salt released from ponds.

In order to solve the governing equations in discrete regions of space (grid cells), a numerical method is required. The three-dimensional TRIM model uses a semi-implicit finite-difference method analyzed in detail by Casulli & Cattani (1994). The solution of the turbulence closure model in TRIM is described in detail by Gross et al. (1999) and the scalar transport method used in the TRIM model is discussed in detail in Gross et al. (1999) and Gross et al. (1998).

4. Existing Conditions Simulations

The existing conditions scenario predicts the salinity conditions in SSFB during 1994. In order to perform this simulation, a large amount of input data was used and the model was calibrated against observations. The details of this effort are provided in ???. In the following sections the model input and model calibration are summarized.

4.1 South San Francisco Bay Model Input

A large amount of model input data is required to simulate salinity in SSFB. This data includes bathymetry data that is used to specify the depth in the model grid, tidal elevation and salinity data near the model boundary, freshwater inflow data including creek flows and WWTP flows, evaporation and precipitation data and wind data.

4.1.1 Model Grid

The model domain of the SSFB model extends from near the Oakland Bay Bridge and includes the major tidal sloughs in SSFB, as shown in Figure 4.1.1-1. The horizontal resolution of the model is 200 meters and the vertical resolution is 1 meter. The model bathymetry was specified using sounding data from NOAA (NOS, 2003), aerial photography data collected by the USGS (Smith and Cheng, 1994) and survey data collected for the Santa Clara Valley Water District.

The grid was rotated 35.40156 degrees counterclockwise to align the channel of SSFB with the model's coordinate system. The model grid dimensions are 33 km (165 grid cells) in the x coordinate direction and 57.6 km (288 grid cells) in the y coordinate direction. The total number of active water columns is 12790 and the total number of active grid cells is 110627.

The resulting bathymetric grid accurately represents the geometry and variations of depth in SSFB. However, the geometry and depth of tidal sloughs are not represented accurately on the 200 meter grid. In order to allow tidal flow into these sloughs they must be at least one grid cell wide, therefore, sloughs which are narrower than 200 meters (during part of all of the tidal cycle) cannot be represented accurately on the 200 meter grid. Therefore, fine grids were generated for the Alviso Region and the Alameda Flood Control Channel.

4.1.2 Hydrology

There are two main categories of freshwater flowing into the South Bay, runoff routed through creeks and effluent discharges from wastewater treatment plants.

The treatment plant flows used in the model are based on historical records from the plant operators. This data was provided in daily or monthly formats; daily flows were used where available.

The freshwater flows used in the salinity simulations are from a variety of sources. Gage data from the USGS and the SCVWD were used where available. Because many of these gaging stations are located substantially upstream of SSFB, adjustments were made to account for ungaged flow.

The freshwater sources included in the model are Adobe Creek, Old Alameda Creek, Stevens Creek, Permanente Creek, San Francisquito Creek, Alameda Creek, Guadalupe River, Coyote Creek, San Tomas Aquino Creek, Calabazas Creek, Sunnyvale East & West Channels, San Jose WWTP, Sunnyvale WWTP and Palo Alto WWTP. The flow in Alameda Creek, the largest tributary to SSFB, is shown in Figure 4.1.2-1.

4.1.3 Wind Data

1994 and 1995 wind data was obtained from the Bay Area Air Quality Management District. Wind data collected at San Carlos Airport was used in the simulations.

4.1.4 Evaporation and Precipitation Data

Monthly pan evaporation collected in Newark, shown in Figure 4.1.4-1, is used in the simulation. Daily precipitation data from San Jose, shown in Figure 4.1.4-2, is used in the bay salinity simulations. The same data is used in the pond salinity simulations. An equation is used to convert pan evaporation to lake evaporation (Linsley et al, 1982) and account for the effect of salinity on evaporation.

4.1.5 Model Setup

The model is used to simulate salinity from March 29, 1994 through June 13, 1995. Salinity at the model boundary is estimated based on the top and bottom salinity data collected by the USGS at the Oakland Bay Bridge, shown in Figure 4.1.5-1. Since this data is available at only one horizontal location, the salinity specified across the model boundary is laterally uniform. This approximation is expected to lead to some error in the model results because lateral variability in SSFB salinity can be considerable (e.g. Huzzey, 1990).

The initial salinity field is specified from the channel salinity profile data collected on March 29, 1994, shown in Figure 4.1.5-2. The salinity profile data were collected between 8:16 am and 12:17 pm as the USGS research vessel moved from station 21, located near the Oakland Bay Bridge, to station 36, located near Calaveras Point. The salinity initial conditions are specified in the model at 10:00 am on March 29, 1994.

As in the hydrodynamic simulations, quiescent initial conditions are assumed. After approximately 10 days of hydrodynamic "spin-up" time, the initial salinity field is specified. The model results are compared to measured salinity data on 32 different dates ranging from March 29, 1994 through June 13, 1995.

4.2 Model Calibration

In the model calibration, the TRIM3D model was shown to accurately predict tidal elevations, tidal currents and salinity in SSFB. The predicted tidal elevations were compared with observations at 5 stations and the predicted tidal currents were compared with observed tidal currents at 15 stations. The amplitude and phase of tidal elevations and tidal currents were predicted accurately. Salinity in the channel of SSFB was predicted during 15 month period including a relatively dry winter period, a summer period, and a wet winter period. Both the seasonal trends and tidal cycle variability of salinity were predicted accurately, typically within 1 ppt of observed salinity. Details of the model calibration are provided in the South Bay Initial Stewardship Plan: South San Francisco Bay Hydrodynamic Model Calibration Report.

4.3 Alviso Region Model

The Alviso Region model is used to provide more detailed and accurate information in the region of interest. The horizontal resolution of the Alviso Region grid, shown in Figure 4.3-1, is 25 meters and the vertical resolution is 25 cm. The bathymetric grid uses the same data sources as the SSFB grid. The input to the Alviso Region model is a subset of the input to the SSFB model.

The inflows included in the Alviso Region model are Stevens Creek, Permanente Creek, Guadalupe River, Coyote Creek, San Tomas Aquino Creek, Calabazas Creek, Sunnyvale East & West Channels, San Jose WWTP and Sunnyvale WWTP. The wind speed and direction data, evaporation data and precipitation data used in the SSFB model was used in the Alviso Region model.

The salinity and water surface elevation specified on the boundary of the Alviso Region model was specified using the salinity and water surface elevation predicted at that location (Calaveras Point) in the SSFB simulations.

In the South Bay Initial Stewardship Plan: South San Francisco Bay Hydrodynamic Model Calibration Report the predicted salinity in the Alviso Region is compared with observed salinity in Coyote Creek, Guadalupe Slough and Artesian Slough. The range of predicted salinity over a typical tidal cycle was similar to the range of observed salinity. In both the predictions and observations the highest salinity during the tidal cycle generally occurred at high water.

4.4 Limitations of Salinity Simulations

The results of the levee breach simulations are discussed in the following sections. Several limitations of the model should be noted in advance. The largest limitation in accuracy is uncertainty in the geometry of the breaches. At any point in time the breach geometry of each breach will depend upon the initial breach geometry that is constructed and the morphological evolution that occurs in the breach and the pond. Because a relatively conservative (wide and deep) initial breach geometry was assumed, the predicted salinity for initial breach conditions is probably conservative overall.

Smaller limitations in model accuracy result from the limited spatial resolution possible with state-of-the-art hydrodynamic models and computers and the limited accuracy of the salinity boundary condition.

The horizontal grid resolution of the three-dimensional model is 25 meters, and the vertical resolution is 25 cm. This high-resolution model contains 225,000 active grid cells, however, the horizontal resolution does limit the accuracy in some regions that are relevant in this analysis. In the portion of Coyote Creek upstream of the junction with Artesian Slough, the low flow (low tide) channel is narrow and, therefore, can only be represented approximately by the model grid. Similarly Mud Slough is narrow and, therefore, is represented approximately on the model grid. In these narrow channels it is not possible to accurately represent the cross-sectional geometry of the channel. Generally the cross-sectional area in the model grid is larger than the actual cross-sectional area in these narrow channels. However, the depth of the model grid in some regions is not as deep as the thalweg depth of the channel. This may limit the model accuracy near low water, and can limit the degree of draining of these channels.

Another factor that may limit the accuracy of the model results is the boundary conditions for salinity and water surface elevation. The boundary conditions that were specified for the breach conditions are identical to the boundary conditions that were specified for existing conditions. This essentially assumes that the island pond breaches do not affect salinity or tidal elevations at Calaveras Point. It is likely that the salinity at Calaveras Point will increase slightly during the initial breach period as a result of the levee breaches. The limited accuracy of the boundary condition for the initial breach scenarios may cause the salinity to be underestimated, particularly near the model boundary at Calaveras Point. The effect of the breaches on tides at Calaveras Point is expected to be negligible.

5. Initial Breach Salinity Scenarios

It is expected that the levee breaches will be constructed at different times so that all island ponds will not begin to discharge simultaneously but, instead, staggered in time. It is also expected that, during the initial breach period, only one levee breach will be open on each pond and that each breach elevation will be above the initial water elevation inside each pond. Therefore one or more incoming tide will enter the ponds before any water is discharged from the island ponds. It is expected that the breach geometry that is constructed will be both narrower and shallower than the long term breach geometry. This will allow gradual discharge of the brine initially in the ponds. The exact geometries of the initial pond breaches in ponds Alviso A19, Alviso A20, and Alviso A21 are not known. For this reason, the results of two different initial breach geometry scenarios are presented in the following sections. The breach geometry of the first scenario has a conservative (larger than likely) breach area while the second scenario has a more conservative breach area. These scenarios are considered conservative because it is likely that the simulations overestimate the rate at which water initially in the island ponds is released to Coyote Creek.

Two scenarios of initial breach conditions have been simulated. Both assume a single 25 meter wide levee breach in each island pond. Because the actual breach width is likely to be less than 25 meters, both scenarios are likely to overestimate salinity increases in Coyote Creek during the initial breach period. The Breach at Pond Bottom Elevation scenario assumes that the elevation of each levee breach is the same as the bottom elevation of the island pond. This is reasonable because it is expected that the initial elevation of the each levee breach for each island pond will be near the bottom elevation of the pond. The Breach at 0 ft NGVD scenario assumes that the breach elevation is 0 ft NGVD. This can be considered a worst-case condition in which the breaches rapidly scour.

For the initial breach salinity simulations the initial salinity is equal to the maximum possible initial salinity given in Table 4.1.5 of the South Bay Salt Ponds Initial Stewardship Plan. Therefore, the initial salinity in ponds Alviso A19, Alviso A20, and Alviso A21 is set to 135 ppt at the time that each pond is breached. The initial water surface elevation in each pond is set to the bottom elevation of Alviso A21, 2.31 ft NGVD. Once the breach occurs, the salinity and water surface elevation in each pond is influenced by flow through the breach and by evaporation and precipitation.

Salinity simulations for island pond initial breach conditions are conducted for 1994 tide, weather and streamflow conditions. 1994 was a relatively dry year. The same initial condition, boundary condition, evaporation and freshwater inflow data used in the salinity simulations for existing conditions are used again in the island pond breach simulations.

The bathymetry of the Alviso Region and the locations of ponds Alviso A19, Alviso A20, and Alviso A21 are shown in Figure 5-1. The horizontal grid resolution for the Alviso

Region grids is 25 meters and the vertical grid spacing is 25 cm. The bathymetry for Alviso Region island pond initial breach simulations is identical to that used for the Alviso Region existing conditions simulation. However, additional bathymetry for ponds Alviso A19, Alviso A20, and Alviso A21 is incorporated. These simulations assume that the ponds have flat bottoms and assume that a 25 m wide borrow ditch inscribes each pond. The borrow ditch is assumed to be located 25 meters inside the levee and is assumed to be uniformly 1.5 m (4.9 ft) deeper than the pond bottom elevation for each pond. For the initial breach salinity simulations, each pond contains a single breach and the width of each breach is assumed to be 25 m. The model grid used in these simulations is shown in Figure 5-1. Because the exact depth of the initial breach is not known, two different breach elevations are considered. The model assumes that each breach connects directly to the main channel in Coyote Creek through a 25 m wide channel which slopes from the breach elevation to the channel elevation. These simulations do not consider the effects of relic channels within the ponds.

Prior to the initiation of the levee breaches in each pond, no flow is allowed into or out of the pond. Following the initial breach, flow may pass freely through the breach opening in either direction. In the island pond initial breach salinity simulations, the breaching of the island ponds is staggered in time, with approximately two days between successive breaches. The assumption that opening the breaches is staggered in time is more realistic than assuming simultaneous breaches. In the simulations, the Alviso A19 levee is breached on July 1, 1994 at 5:30 pm, the Alviso A20 levee is breached on July 3, 1994 at 6:30 pm, and the Alviso A21 levee is breached on July 5, 1994 at 8:00 pm. During the subsequent incoming tide, inflow of bay water into the pond mixes with the water initially in the pond. This mixing lowers the salinity of the water in the ponds that is subsequently discharged on the falling tide. The exact amount of mixing that will occur within the ponds during the initial release will depend on wind and tidal conditions at the time of the breach. Under strong wind and tidal conditions more complete mixing is expected which would lower the maximum salinity released from the ponds; under weak winds and tides less complete mixing and greater stratification would be expected in the ponds.

5.1 Breach at Pond Bottom Elevation

The scenario discussed in this section assumes that the breach elevation in each pond is equal to the elevation of the pond bottom and the breach width is 25 m. This scenario provides a conservative estimate of the initial release of the pond water because, though it is expected that the initial breach elevation may be near the pond bottom elevation, it is likely that the initial breach width will be less than 25 m. For each pond, the bottom, borrow ditch, breach, and initial water surface elevation used in this scenario is shown in Table 5.1-1. As seen in Table 5.1-1, the initial depth of Alviso A19 is 0.55 ft, and the initial depth of Alviso A20 is 0.48 ft. The initial water depth of Alviso A21 is 0 ft and the borrow ditch inscribing the pond has an initial water depth of 4.92 ft.

Table 5.1-1 Pond Bottom, Borrow Ditch, Breach, and Initial Water Surface Elevations for Breach at Pond Bottom Elevation Scenario

Pond Name	Pond Area (acres)	Pond Bottom Elevation (ft NGVD)	Borrow Ditch Elevation (ft NGVD)	Breach Elevation (ft NGVD)	Initial Water Elevation (ft NGVD)
Alviso A19	265	1.76	-3.16	1.76	2.31
Alviso A20	63	1.83	-3.09	1.83	2.31
Alviso A21	147	2.31	-2.61	2.31	2.31

In all of the ponds considered in this scenario, the flow into and out of the ponds, and the subsequent rate at which the initial water in the ponds mixes into Coyote Creek, is limited by the breach elevation. Since the lowest breach elevation considered in this scenario is 1.76 ft NGVD, flow can only enter through the breach when the water in Coyote Creek exceeds 1.76 ft NGVD (or 1.83 and 2.31 ft NGVD for ponds Alviso A20 and Alviso A21, respectively). This typically occurs only for a short time during the tidal cycle near high water. In addition, because the breach elevation is 4.92 ft higher than the borrow ditch bottom elevation, the borrow ditches remain full during the simulation and serve as reservoirs that hold much of the initial water in the ponds and allow it to be mixed with water that flows into the ponds from Coyote Creek over several tidal cycles. As a result, the initial water in the island ponds mixes out and is released over a period of approximately 1 to 2 weeks.

Figures 5.1-1 through 5.1-3 show the predicted depth-averaged salinity at the location of each of the three island pond breaches during the month of July. As seen in these figures, the predicted salinity at the breach locations falls rapidly from the initial value of 135 ppt. The first initial pulse of bay water into the pond mixes with the water in the pond causing a large drop in predicted salinity. As the tide reverses, some water flows out of the pond and the remaining water in the pond retains a high predicted salinity. Each subsequent pulse of bay water into the pond results in a decrease in predicted salinity at the breach location. The predicted salinity at the breach locations decreases rapidly and falls below 25 ppt within two weeks of the opening of the levee breaches.

The predicted salinity for the Breach at Pond Bottom Elevation scenario is compared to the predicted salinity for existing conditions by multiple methods. In the first method, maps of depth-averaged and daily-averaged predicted salinity in each grid cell of the model grid are shown. The maps show predicted salinity for existing conditions, predicted salinity for the Breach at Pond Bottom Elevation scenario, and the difference in predicted salinity for the two cases, computed by subtracting the predicted salinity for existing conditions from the predicted salinity for the Breach at Pond Bottom Elevation scenario. The salinity difference maps show the average effect of the levee breaches. The second method is to compare the longitudinal and vertical salinity distribution (profile) along the centerline of Coyote Creek at different instants in time using contour plots. The third method is to compare the continuous record of predicted salinity at various locations. These time series comparisons clearly show the range of predicted salinity experienced over the tidal cycle and the longer term variability of predicted salinity for both existing conditions and the Breach at Pond Bottom Elevation scenario.

Figures 5.1-4 through 5.1-13 show the predicted depth-averaged and daily-averaged salinity for existing conditions, for the Breach at Pond Bottom Elevation scenario, and the predicted salinity increases resulting from the island pond levee breaches. On Figure 5.1-4, the predicted salinity is shown to range from 0 to 25 ppt in the Alviso Region on 7/1/1994 for both existing conditions and the Breach at Pond Bottom Elevation scenario. The largest predicted salinity occurs near Calaveras Point while the lowest predicted salinity generally occurs in Artesian Slough, due to the San Jose WWTP discharge, and at other locations where freshwater inflows enter the Alviso Region. Predicted salinity increases on 7/1/1994 resulting from the Alviso A19 breach range from 0 to 2 ppt and are evident only immediately adjacent to the breach.

Figure 5.1-5 shows that on 7/2/1994, the day following the Alviso A19 breach, the predicted salinity range in the Alviso Region is 0 to 26 ppt for both existing conditions and the Breach at Pond Bottom Elevation scenario. Predicted salinity increases in the Alviso Region range from 0 ppt to approximately 16 ppt. The greatest predicted salinity increases are seen in the region of Coyote Creek adjacent to and upstream of the island ponds.

Figure 5.1-6 shows that on 7/3/1994, the day of the Alviso A20 breach, the predicted salinity range is again 0 to 26 ppt for both existing conditions and the Breach at Pond Bottom Elevation scenario. Predicted salinity increases in the Alviso Region range from 0 ppt to approximately 16 ppt. The greatest predicted salinity increases occur in the region of Coyote Creek adjacent to and upstream of the island ponds. Predicted salinity increases of 3 to 10 ppt are predicted in Mud Slough and increases of 0 to 2 ppt are predicted in Alviso Slough.

Predicted salinity increases in the Alviso Region on 7/4/1994 range from 0 to 18 ppt with the greatest increases predicted in the region of Coyote Creek adjacent to the island ponds. On 7/5/1994 and 7/6/1994 predicted salinity increases in the Alviso Region range from 0 to 12 ppt. The greatest predicted salinity increase in the Alviso Region is seen on 7/6/1994 and 7/7/1994, shown on Figures 5.1-9 and 5.1-10, respectively. Smaller increases are predicted on 7/14/1994, 7/21/1994, and 7/28/1994. Predicted daily-averaged and depth-averaged salinity increases in the Alviso Region on 7/28/1994, shown on Figure 5.1-13, range from 0 to 6 ppt.

In the second comparison method, the predicted salinity for the Breach at Pond Bottom Elevation scenario is compared to the predicted salinity for existing conditions using salinity profiles along Coyote Creek. The centerline of Coyote Creek is defined by the stations shown in Figure 5.1-14. The predicted salinity along the centerline of Coyote Creek is shown by the salinity contour plots in Figures 5.1-15 through 5.1-24. The top panel shows predicted salinity for existing conditions and the bottom panel shows predicted salinity for the Breach at Pond Bottom Elevation scenario. In all cases the predicted salinity is shown when the tides are near high water.

Figure 5.1-15 shows that on 7/1/1994, the day of the initial levee breach on Alviso A19, the predicted channel salinity in Coyote Creek ranges from 4 ppt to over 24 ppt for both existing conditions and the Breach at Pond Bottom Elevation scenario. At this time, water is still flowing into the pond through the breach and there is only a very slight shift in the predicted salinity contours for the Breach at Pond Bottom Elevation scenario.

The predicted salinity profiles on 7/2/1994, shown on Figure 5.1-16, show that near high water there is only a small increase in predicted salinity downstream of Alviso A21. Upstream of Alviso A21, there is a noticeable increase in predicted salinity due to the breach on Alviso A19. Predicted salinity increases range from approximately 0 to 16 ppt; the increase in predicted salinity extends as much as 4 km upstream of the Alviso A19 breach.

The predicted salinity on 7/3/1994, the day of the Alviso A20 breach is shown on Figure 5.1-17. On 7/3/1994 there is an increase in predicted salinity for the region upstream of Alviso A21. The predicted salinity increase ranges from 0 to 14 ppt. Salinity profiles on 7/4/1994 and 7/5/1994 show predicted salinity increases upstream of Alviso A21.

Figures 5.1-21 through 5.1-23 show the predicted salinity profiles at one week intervals from 7/7/1994 through 7/21/1994. The largest predicted salinity increase is seen on 7/6/1994 and 7/7/1994, with smaller increases predicted for 7/14/1994 and 7/21/1994. As seen in these figures, the predicted salinity increase from the Breach at Pond Bottom Elevation scenario decreases gradually over time following the initial breaches. The predicted salinity profile on 7/21/1994 shows a 1 km upstream shift of the 16 ppt contour and a predicted salinity increase upstream of the Alviso A19 breach of 0 to 6 ppt. On 7/28/1994 there is a small upstream shift of the 16 ppt and 12 ppt contours and a predicted salinity increase upstream of the Alviso A19 breach of up to 5 ppt, as shown on Figure 5.1-24.

In the third comparison method, the predicted salinity for the Breach at Pond Bottom Elevation scenario is compared to the predicted salinity for existing conditions time series salinity plots at selected locations along Coyote Creek. Figure 5.1-25 shows the predicted salinity at a distance of 1 km from the mouth of Coyote Creek under existing conditions and the Breach at Pond Bottom Elevation scenario during July 1994. As seen in this figure, the predicted salinity range under the Breach at Pond Bottom Elevation scenario largely overlaps with the range under existing conditions. This figure shows that the increase in the maximum predicted salinity during each tidal cycle under the Breach at Pond Bottom Elevation scenario is typically less than 0.5 ppt. However, at low water, the predicted salinity at this location of Coyote Creek is as much as 10 ppt higher under the Breach at Pond Bottom Elevation scenario than existing conditions. The greatest predicted salinity increases at low water are seen during the two week period following the initiation of the island pond breaches. This shows that the increase in predicted daily-averaged salinity observed near the mouth of Coyote Creek can be largely attributed to an increase in the minimum predicted salinity during the tidal cycle, which generally occurs near low water, rather than an increase in the maximum predicted salinity, which generally occurs near high water.

The predicted salinity at the 3 km station in Coyote Creek, shown in Figure 5.1-26, similarly shows a small increase in maximum predicted salinity at high water and an increase of as much as 15 ppt during low water, when predicted salinity is at a minimum.

Figure 5.1-27 shows the predicted salinity at a distance of 5 km from the mouth of Coyote Creek under existing conditions and the Breach at Pond Bottom Elevation scenario. During the week following the initiation of the island pond breaches, the predicted salinity at the 5 km station ranges from 4 to 26 ppt for existing conditions and 4 to 27 ppt for the Breach at Pond Bottom Elevation scenario. The predicted salinity at this location increases by 1 to 6 ppt at higher high water and increases at low water by up to 18 ppt during the first week. Therefore, the maximum salinity predicted at this station under the Breach at Pond Bottom Elevation scenario is only slightly higher than under existing conditions, but the range of salinity is reduced during the first week following the levee breaches.

The predicted salinity at the 7 km and 9 km stations in Coyote Creek, shown in figures 5.1-28 and 5.1-29, respectively, increases over the entire tidal cycle during the two weeks following the initiation of the island pond breaches. As seen on Figure 5.1-28, the predicted salinity at higher high water near the 7 km station increases by as much as 5 ppt during the month of July.

Figure 5.1-30 shows the predicted salinity at a distance of 11 km from the mouth of Coyote Creek under existing conditions and the Breach at Pond Bottom Elevation scenario. At this location, the predicted salinity under existing conditions is relatively low and typically ranges from 5 ppt to 11 ppt in July. The predicted salinity the Breach at Pond Bottom Elevation scenario at this location ranges from approximately 10 ppt to over 20 ppt during this period. The greatest predicted salinity increases occur during the first two weeks of July, while predicted salinity increases in the second two weeks are approximately 5 ppt.

The Breach at Pond Bottom Elevation scenario simulations, with breach elevation in each pond equal to the pond bottom elevation, show that predicted salinity increases of up to 15 ppt are expected in the channel of Coyote Creek adjacent to the island ponds during the period following the initiation of the breaches. The greatest salinity increases are predicted during the first two weeks following the levee breaches, but predicted salinity increases of approximately 5 ppt are predicted in the portion of Coyote Creek adjacent to the island ponds one month after the initiation of the levee breaches. The predicted salinity increases that are present one month after the pond breaches are at least partially due to changes in hydrodynamics (tidal prism, velocity, etc.) that result from the levee breaches.

5.2 Breach at 0 Feet NGVD

The scenario discussed in this section assumes that the breach elevation in each pond is 0 ft NGVD and the breach width is 25 m. Because the breach elevations in this scenario, which will be referred to as the Breach at 0 ft NGVD scenario, are lower than in the Breach at Pond Bottom Elevation scenario, less water is retained in the borrow ditches at low water and the water initially in the ponds mixes into Coyote Creek more rapidly. As a result, the Breach at 0 Feet NGVD scenario provides a more conservative estimate of the initial release of the pond water than the Breach at Pond Bottom Elevation scenario because it allows more exchange between the island ponds and Coyote Creek, and, therefore, a larger predicted salinity increase in Coyote Creek.

For each pond, the bottom, borrow ditch, breach, and initial water surface elevation used in this simulation is shown in Table 5.2-1. As seen in Table 5.2-1, the initial depth of Alviso A19 is 0.55 ft, and the initial depth of Alviso A20 is 0.48 ft. The initial water depth of Alviso A21 is 0 ft. For Alviso A21, the water elevation is near the pond bottom elevation and, therefore, the borrow ditch inscribing the pond has an initial water depth of 4.92 ft. Once the breach occurs, the borrow ditch depth is reduced to 2.61 ft at low water.

Table 5.2-1 Pond Bottom, Borrow Ditch, Breach, and Initial Water Surface Elevations for the Breach at 0 ft NGVD Scenario

Pond Name	Pond Area (acres)	Pond Bottom Elevation (ft NGVD)	Borrow Ditch Elevation (ft NGVD)	Breach Elevation (ft NGVD)	Initial Water Elevation (ft NGVD)
Alviso A19	265	1.76	-3.16	0.0	2.31
Alviso A20	63	1.83	-3.09	0.0	2.31
Alviso A21	147	2.31	-2.61	0.0	2.31

In all of the ponds considered in this scenario, the flow into and out of the ponds, and the subsequent rate at which the initial water in the ponds mixes into Coyote Creek, is somewhat limited by the breach elevation. Since the breach elevations considered in this scenario are set to 0 ft NGVD, flow can only enter through the breach when the water in Coyote Creek exceeds 0 ft NGVD. This typically occurs during approximately half of a typical tidal cycle. In addition, because the breach elevation is higher than the borrow ditch bottom elevation, the borrow ditches remain partially full during the simulation and serve as reservoirs that hold much of the initial water in the ponds and allow it to be mixed with water that flows into the ponds from Coyote Creek over several tidal cycles. However, relative to the previous scenario, the initial release from the island ponds is less limited by the breach elevation and therefore the release occurs more rapidly.

Figures 5.2-1 through 5.2-3 show the predicted depth-averaged salinity at the location of each of the three island pond breaches during the month of July. As seen in these figures, the predicted salinity at the breach locations falls rapidly from the initial value of 135 ppt. The first initial pulse of bay water into the pond mixes with the water in the pond causing a large drop in predicted salinity. As the tide reverses, this water flows out of the pond and the remaining water in the pond retains a high predicted salinity. Each subsequent pulse of bay water into the pond results in a decrease in predicted salinity at the breach location. The predicted salinity at the breach locations decreases rapidly and falls below 25 ppt within one week of opening the levee breaches.

The predicted salinity for the Breach at 0 ft NGVD scenario is compared to the predicted salinity for existing conditions by multiple methods. In the first method, maps of depth-averaged and daily-averaged predicted salinity in each grid cell of the model grid are shown. The maps show predicted salinity for existing conditions, predicted salinity for the Breach at 0 ft NGVD scenario and the difference in predicted salinity for the two cases, computed by subtracting the predicted salinity for existing conditions from the predicted salinity for the Breach at 0 ft NGVD scenario. The salinity difference maps show the average effect of the discharges from the levee breaches. The second method is to compare the longitudinal and vertical salinity distribution (profile) along the centerline of Coyote Creek at different instants in time using contour plots. The third method is to compare the continuous record of predicted salinity at various locations. These time series comparisons clearly show the range of predicted salinity experienced over the tidal cycle and the longer term variability of predicted salinity for both existing conditions and the Breach at 0 ft NGVD scenario.

Figures 5.2-4 through 5.2-13 show the predicted depth-averaged and daily-averaged salinity for existing conditions, the Breach at 0 ft NGVD scenario, and the predicted salinity increases resulting from the island pond levee breaches with a breach elevation of 0 ft NGVD. On Figure 5.2-4, the predicted salinity is shown to range from 0 to 25 ppt in the Alviso Region on 7/1/1994 for both existing conditions and the Breach at 0 ft NGVD scenario. The largest predicted salinity occurs near Calaveras Point while the lowest predicted salinity generally occurs in Artesian Slough, due to the San Jose WWTP discharge, and at other locations where freshwater inflows enter the Alviso Region. Predicted salinity increases on 7/1/1994 resulting from the Alviso A19 breach range from 0 to 4 ppt, and increases greater than 1 ppt are only observed adjacent to ponds Alviso A20 and Alviso A19.

Figure 5.2-5 shows that on 7/2/1994, the day following the Alviso A19 breach, the predicted salinity range is 0 to 26 ppt for existing conditions and 0 to 35 ppt for the Breach at 0 ft NGVD scenario. Predicted salinity increases in the Alviso Region range from 0 ppt to over 24 ppt. The greatest predicted salinity increases are seen in the region of Coyote Creek adjacent to and upstream of the mouth of Alviso Slough.

Figure 5.2-6 shows that on 7/3/1994, the day of the Alviso A20 breach, predicted salinity increases in the Alviso Region range from 0 ppt to approximately 18 ppt. The greatest predicted salinity increases are seen in the region of Coyote Creek adjacent to the island ponds. Salinity increases of 5 to 10 ppt are predicted in Mud Slough, and increases of 3 to 5 ppt are predicted in a portion of Alviso Slough.

Figure 5.2-7 shows the predicted salinity increases on 7/4/1994 in the Alviso Region range from 0 to 18 ppt and are similar in range and distribution to increases on 7/3/1994. Figure 5.2-8 and 5.2-9 show that on 7/5/1994 and 7/6/1994 predicted salinity increases in the Alviso Region range from 0 to 14 ppt. Predicted salinity maps for 7/7/1994, 7/14/1994, 7/21/1994, and 7/28/1994 show that after the initiation of the breaches, the predicted increase in salinity decreases over time. Predicted salinity increases in the Alviso Region on 7/28/1994, shown on Figure 5.2-13, range from 0 to 6 ppt.

In the second comparison method, the predicted salinity for the Breach at Pond Bottom Elevation scenario is compared to the predicted salinity for existing conditions using salinity profiles along Coyote Creek. The centerline of Coyote Creek is defined by the stations shown in Figure 5.1-14. The predicted salinity along the centerline of Coyote Creek is shown by the salinity profile plots in Figures 5.2-14 through 5.2-23. . The top panel shows predicted salinity for existing conditions and the bottom panel shows predicted salinity for the Breach at 0 ft NGVD scenario. In all cases the predicted salinity is shown when the tides are near high water.

Figure 5.2-14 shows that on 7/1/1994, the day of the initial levee breach on Alviso A19, the predicted channel salinity in Coyote Creek ranges from 4 ppt to over 24 ppt for both existing conditions and the Breach at 0 ft NGVD scenario.

The predicted salinity profiles on 7/2/1994, shown on Figure 5.2-15, indicate that the predicted channel salinity in Coyote Creek ranges from 4 ppt to over 24 ppt existing conditions and 8 to over 24 ppt for the Breach at 0 ft NGVD scenario, and that under the Breach at 0 ft NGVD scenario the predicted salinity is approximately 24 ppt in most of Coyote Creek.

The predicted salinity profiles on 7/3/1994, the day of the Alviso A20 breach, are shown on Figure 5.2-16. On 7/3/1994 the predicted salinity ranges from 4 to 28 ppt for both and for existing conditions and the Breach at 0 ft NGVD scenario, with the highest salinity predicted near Calaveras Point. Salinity increases of 1 to 20 ppt are predicted in a large portion of Coyote Creek near the levee breaches.

Predicted salinity profiles shown on Figures 5.2-17 and 5.2-18, for 7/4/1994 and 7/5/1994, show that under the Breach at 0 ft NGVD scenario the predicted salinity is increased near the island ponds as a result of the levee breaches, typically by 1 to 16 ppt but that the range of predicted salinity in Coyote Creek is the same under both existing conditions and the Breach at 0 ft NGVD scenario.

Figures 5.2-20 through 5.2-23 show the predicted salinity contours at one week intervals from 7/7/1994 through 7/28/1994. As seen in these figures, the predicted salinity increase from the Breach at Pond Bottom Elevation scenario decreases gradually over time following the initial breaches. The predicted salinity profile on 7/21/1994 shows a 1 km upstream shift of the 16 ppt and 20 ppt contours and a salinity increase upstream of the Alviso A19 breach of 4 to 8 ppt. Figure 5.2-23 shows that on 7/28/1994 there is a small upstream shift of the 16 ppt and 12 ppt contours and a predicted salinity increase upstream of the Alviso A19 breach of approximately 4 to 8 ppt.

In the third comparison method, the predicted salinity for the Breach at Pond Bottom Elevation scenario is compared to the predicted salinity for existing conditions time series salinity plots at selected locations along Coyote Creek. Figure 5.2-24 shows the predicted salinity at a distance of 1 km from the mouth of Coyote Creek under existing conditions and the Breach at 0 ft NGVD scenario during July 1994. The predicted salinity range for existing conditions is 14 to 28 ppt and for the Breach at 0 ft NGVD scenario is 16 to 32 ppt. This figure shows that the increase in the maximum predicted salinity during each tidal cycle under ISP conditions is typically less than 0.5 ppt, with the exception of two days immediately following the initiation of the levee breaches.

The predicted salinity at the 3 km station in Coyote Creek, shown in Figure 5.2-25, ranges from 8 to 28 ppt for existing conditions and from 10 to 32 ppt for the Breach at 0 ft NGVD scenario. The predicted increases in maximum predicted salinity during each tidal cycle are generally much smaller than the increases in minimum predicted salinity, which general occur near low water during each tidal cycle.

Figure 5.2-26 shows the predicted salinity at a distance of 5 km from the mouth of Coyote Creek under existing conditions and the Breach at 0 ft NGVD scenario. During the week following the initiation of the island pond breaches, the maximum predicted salinity at the 5 km station increases by up to 12 ppt as a result of the levee breaches. Following the initial week of breach conditions, the predicted salinity increases by 1 to 4 ppt at high water and by approximately 6 ppt at low water.

The 7 km and 9 km stations are located adjacent to the island ponds and, therefore, the greatest predicted salinity increases are present at these stations. The predicted salinity at the 7 km station in Coyote Creek, shown in Figure 5.2-27, respectively, ranges from 3 to 22 ppt under existing conditions, and 3 to 40 ppt under the Breach at 0 ft NGVD scenario, during the first week of July. The predicted salinity at the 9 km station in Coyote Creek, shown in Figure 5.2-28, respectively, ranges from 3 to 15 ppt under existing conditions, and 3 to 35 ppt under the Breach at 0 ft NGVD scenario, during the first week of July. After the first week of July, the predicted salinity at the 7 km station and 9 km station increases by 3 to 10 ppt as a result of the levee breaches.

Figure 5.2-29 shows the predicted salinity at a distance of 11 km from the mouth of Coyote Creek under existing conditions and the Breach at 0 ft NGVD scenario. At this location, the predicted salinity under existing conditions typically ranges from 5 ppt to 11 ppt in July. The predicted salinity the Breach at 0 ft NGVD scenario at this location ranges from approximately 10 to 25 ppt during this period. Thus the predicted salinity increase at this location extends over the entire tidal cycle. The largest predicted salinity increases occur during the first week of July, while increases in subsequent weeks are approximately 5 ppt to 10 ppt. This figure shows that at the 11 km station in Coyote Creek, located near Warm Springs Marsh, predicted salinity increases by 5 to 7 ppt one month after the initial breach as a result of the levee breaches.

The Breach at 0 ft NGVD scenario indicates that salinity may increase by up to 25 ppt in the region of Coyote Creek adjacent to the island ponds during the first week following the initiation of the breaches. The greatest salinity increases are predicted during the week following the levee breaches, but predicted salinity increases of up to 7 ppt are predicted in the channel of Coyote Creek adjacent to the island ponds one month after the levees are breached.

Compared to the Breach at Pond Bottom Elevation scenario discussed in the previous section, the Breach at 0 ft NGVD scenario allowed high salinity water from the ponds to be released more rapidly which caused the predicted salinity in the ponds to drop more rapidly and caused larger short term increases in predicted salinity in Coyote Creek. For the second two weeks in July, both cases showed similar results. Downstream of the island ponds the maximum predicted salinity during each tidal cycle increased slightly, while a sizeable increase in the minimum predicted salinity during each tidal cycle was predicted to occur as a result of the levee breaches.

In the region of Coyote Creek adjacent to the island ponds, the Breach at 0 ft NGVD scenario indicated predicted salinity increases of 5 to 7 ppt during the second two weeks of July. These salinity increases that occur weeks after the levees are breached result primarily from the increased tidal prim that is present in Coyote Creek as a result of the levee breaches. The long term predicted salinity increases resulting from the levee breaches will be discussed in the following section.

6. Long Term Breach Scenario

Breaching the levees of the island ponds effectively increases the surface area of South San Francisco Bay. Although the area of the island ponds is small relative to the total area of SSFB, it is sizeable relative to the surface area of Coyote Creek. Therefore considerable effects on velocity, tidal prism, tidal elevation and salinity in Coyote Creek can be expected as a result of the levee breaches. However, the magnitude of the effects on hydrodynamics and salinity in Coyote Creek depend to a large extent on the breach geometry.

Over time, it is assumed that each breach will deepen and could reach a depth near the elevation of the bottom of the borrow ditch surrounding the pond. A breach depth at the borrow ditch bottom elevation would allow tidal range in the island ponds approximately equal to the tidal range in Coyote Creek and maximum exchange between the ponds and Coyote Creek. Maximum volume exchange between the ponds and Coyote Creek corresponds to the largest expected differences in hydrodynamics, tidal prism, and velocity in Coyote Creek. Thus, this simulation is used to assess changes in velocity, tidal prism, tidal elevation and salinity that could potentially result from breaching the levees in ponds Alviso A19, Alviso A20, and Alviso A21.

The geometry of each breach used in this simulation is conservative in that it assumes that the breaches are scoured to a fairly large cross-sectional area under long term conditions. Furthermore it assumes that the bottom elevations in the ponds and borrow ditches are equal to current elevations at the time that the breaches have eroded to the assumed long term conditions. Based on observations in Warm Springs Marsh (Williams et al., 2002), it is more likely that the breaches will erode slowly and that considerable deposition will occur in the island ponds before the breach geometry reaches an equilibrium morphology. This more realistic evolution would result in smaller changes in the hydrodynamics of Coyote Creek than those estimated in this study.

The bathymetry used in the simulation is based on existing conditions in the Alviso Region. Therefore, it does not account for possible effects on the bathymetry of Coyote Creek, such as scour in regions of Coyote Creek adjacent to the island ponds. However, in Section 6.2.5 an estimate is made of the degree of scour that may result in Coyote Creek as a result of the levee breaches.

Simulations for the Long Term Breach scenario are conducted for 1994, a relatively dry year. The same initial condition, boundary condition, evaporation and freshwater inflow data used in the salinity simulations for existing conditions are used again in these simulations.

The model bathymetry for the long term simulations is identical to that used in the initial breach simulations with the exception of the number of levee breaches and the levee breach geometry. The model grid used in the Long Term Breach scenario simulations is shown in Figure 6-1. The horizontal grid resolution for the Alviso Region grid is 25 meters and the vertical grid spacing is 25 cm. This scenario assumes that the ponds have flat bottoms and that a 25 m wide borrow ditch inscribes each pond. The borrow ditch is assumed to be located 25 meters inside the levee and is assumed to be uniformly 4.9 ft deeper than the pond bottom elevation for each pond. The elevation of the ponds, borrow ditches and breaches are given in Table 6-1.

Under long term operation, it is expected that multiple breaches may be opened on ponds Alviso A19, Alviso A20, and Alviso A21. In this analysis, Alviso A19 and Alviso A21 are breached in two locations and pond A20 is breached in one location. The width of each breach is 25 m and the elevation of the breach is set to the borrow ditch bottom elevation. Each breach is connected to main channel in Coyote Creek by a 25 m wide channel with the same bottom elevation as the corresponding breach and borrow ditch.

Table 6-1 Pond Bottom, Borrow Ditch, and Breach Elevations for Long Term Breach Scenario

Pond Name	Pond Area (acres)	Pond Bottom Elevation (ft NGVD)	Borrow Ditch Elevation (ft NGVD)	Breach Elevation (ft NGVD)
Alviso A19	265	1.76	-3.16	-3.16
Alviso A20	63	1.83	-3.09	-3.09
Alviso A21	147	2.31	-2.61	-2.61

6.1 Long Term Salinity

In the Long Term Breach scenario there is no initial salt mass in the ponds. The five levee breaches are open at the beginning of the simulation and bay water flows freely through the breaches in either direction. During the simulation, the salinity and water surface elevation in each pond is influenced by inflow to the pond through the breach and by evaporation.

The Long Term Breach salinity simulation begins on 6/14/1994 and runs through 8/4/1994. Unlike the initial breach simulations, the ponds begin this simulation with open breaches. For the long term salinity analysis the month of July is analyzed. The model results during first two weeks of the simulation are not considered to allow for model spin-up.

The salinity in the Alviso Region is affected by freshwater inflows, tidal mixing of salt water from SSFB, evaporation and precipitation. The freshwater inflows from rivers, creeks and treatment plants will not be changed by the levee breaches. In contrast the degree of tidal mixing may change considerably as a result of the increased tidal prism and tidal velocities in Coyote Creek. The primary effect would be to transport more saline water from SSFB into Coyote Creek during rising (flood) tides. A considerable water volume and salt mass may be moved into the island ponds during strong flood tides, which would drain during the following ebb tide. Therefore, the island ponds would act as reservoirs that store water volume and salt mass and discharge it back to Coyote Creek later in each tidal cycle.

The evaporation from the island ponds and precipitation on the island ponds would also affect salinity in Coyote Creek subsequent to breaching the island ponds. Currently there is no discharge from the island ponds to any part of SSFB or associated tidal sloughs, and therefore, evaporation and precipitation on the island ponds do not directly affect bay salinity. Under breached conditions the island ponds would function as part of the bay and, therefore, evaporation and precipitation over this area would directly affect salinity in Coyote Creek and, to a lesser extent, SSFB.

Figures 6.1-1 through 6.1-3 show the predicted salinity for the Long Term Breach scenario in ponds Alviso A19, Alviso A20, and Alviso A21, respectively. As seen in Figure 6.1-1, the predicted salinity in Alviso A19 ranges from approximately 12 to 17 ppt during July. Salinity in the pond varies on both a daily and spring-neap time scale. Predicted salinity in ponds Alviso A20 and Alviso A21 shows similar variability with predicted salinity ranges of 8 to 17 ppt and 11 to 19 ppt, respectively. These figures show that, under the Long Term Breach scenario, salinity in the island ponds can sometimes be higher than salinity in adjacent areas of Coyote Creek. As a result, exchange between the island ponds and Coyote Creek can potentially influence salinity in the Alviso Region under the Long Term Breach scenario. The predicted salinity differences that may occur in the Alviso Region due to the proposed levee breaches are discussed in this section.

The predicted salinity for the Long Term Breach scenario in the Alviso Region is compared to the predicted salinity for existing conditions by multiple methods. In the first method, maps of depth-averaged and daily-averaged predicted salinity in each grid cell of the model grid are shown. The maps show predicted salinity for existing conditions, predicted salinity for the Long Term Breach scenario, and the difference in predicted salinity for the two cases, computed by subtracting the predicted salinity for existing conditions from the predicted salinity for the Long Term Breach scenario. The salinity difference maps show the average effect of the discharges from the levee breaches. The second method is to compare the longitudinal and vertical salinity distribution (profile) along the centerline of Coyote Creek at different instants in time using contour plots. The third method is to compare the continuous record of predicted salinity at various locations. These time series comparisons clearly show the range of predicted salinity experienced over the tidal cycle and the longer term variability of predicted salinity for both existing conditions and the Long Term Breach scenario.

Figures 6.1-4 through 6.1-8 show the predicted daily-averaged and depth-averaged salinity for existing conditions, the Long Term Breach scenario, and the predicted salinity increases resulting from the island pond levee breaches. The predicted salinity range on 7/1/1994, shown on Figure 6.1-4, is approximately 0 to 30 ppt for both existing conditions and the Long Term Breach scenario, and predicted salinity increases of approximately 6 ppt are present in the portion of Coyote Creek adjacent to Alviso A19.

The predicted salinity range on 7/7/1994, 7/14/1994, 7/21/1994 and 7/28/1994, shown on Figures 6.1-5 through 6.1-8 is similar. On all of these dates, the daily-averaged and depth-averaged predicted salinity ranges from 0 to approximately 30 ppt for both existing conditions and the Long Term Breach scenario, and predicted salinity increases of 4 to 8 ppt are present in the portion of Coyote Creek adjacent to the island ponds. Predicted salinity increases of 1 to 4 ppt are present in other regions of Coyote Creek and Mud Slough. Predicted salinity increases are less than 1 ppt in the portion of Coyote Creek between Calaveras Point and Alviso Slough. However, the predicted salinity in this region is strongly influenced by the salinity boundary condition used in the model. Since the same boundary condition was used for existing conditions and the Long Term Breach scenario, the negligible salinity increase in this region predicted in this analysis may be smaller than the actual salinity increase that would result from the levee breaches.

In the second comparison method, the predicted salinity for the Breach at Pond Bottom Elevation scenario is compared to the predicted salinity for existing conditions using salinity profiles along Coyote Creek. The centerline of Coyote Creek is defined by the stations shown in Figure 5.1-14. The predicted salinity along the centerline of Coyote Creek is shown by the salinity contour plots in Figures 6.1-9 through 6.1-13. The top panel is a contour plot of predicted salinity for existing conditions and the bottom panel is a contour plot of predicted salinity for the Long Term Breach scenario. In all cases the predicted salinity is shown when the tides are near high water. Figure 6.1-9 shows that on 7/1/1994 the salinity in the portion of Coyote Creek adjacent to the island ponds is increased by 2 to 7 ppt. The salinity range in Coyote Creek is approximately 5 to 27 ppt for existing conditions and 10 to 27 ppt for the Long Term Breach scenario. The island pond levee breaches have little effect on predicted salinity near the mouth of Coyote Creek. However, because the boundary condition used for the Long Term Breach scenario is the same boundary condition that was used for the existing conditions simulation, the predicted salinity in the region near the boundary (within 3 to 5 km) will generally be similar for the two scenarios near high water.

On 7/7/1994, 7/14/1994, 7/21/1994 and 7/28/1994, shown on Figures 6.1-10 through 6.1-13, the results are similar to the results for 7/1/1994. In all cases the salinity range is from less than 8 ppt to more than 28 ppt for existing conditions, and less than 12 ppt to more than 28 ppt for the Long Term Breach scenario. The largest predicted salinity increases occur in the reach of Coyote Creek bordering the island ponds and are typically in the range of 2 to 8 ppt.

Figure 6.1-14 shows the predicted salinity at a distance of 1 km from the mouth of Coyote Creek under existing conditions and the Long Term Breach scenario for July. At this location the predicted salinity range under both existing conditions and the Long Term Breach scenario is 14 to 29 ppt. This figure shows that predicted salinity differences occur only near low water. The predicted salinity at the 3 km station in Coyote Creek, shown in 6.1-15, similarly shows a salinity range of 8 to 28 ppt for existing conditions and 12 to 28 ppt for the Long Term Breach scenario.

Figure 6.1-16 shows that the predicted salinity at a distance of 5 km from the mouth of Coyote Creek under existing conditions ranges from 4 to 27 ppt while the predicted salinity ranges from 8 to 27 ppt for the Long Term Breach scenario. Increases in maximum predicted salinity, which occurs near high water, are typically less than 1 ppt. The predicted salinity at the 7 km station, near Alviso A20, shown in Figure 6.1-17, typically increases by 3 and 7 ppt and the predicted salinity increases persist through the entire tidal cycle. At the 9 km station, located near the upstream edge of Alviso A19, shown on Figure 6.1-18, there is an increase in predicted salinity of 4 to 10 ppt during each tidal cycle. At the 11 km station, located near Warm Springs Marsh, shown on Figure 6.1-20, the predicted salinity increases by 4 to 7 ppt as a result of the island pond levee breaches.

The salinity modeling of the Long Term Breach scenario shows a persistent increase in predicted salinity during summer in the channel of Coyote Creek adjacent to the island ponds and in Warm Springs Marsh. In these areas, predicted salinity is typically 3 to 8 ppt higher under the Long Term Breach scenario than under existing conditions. Smaller salinity increases of between 2 and 5 ppt are predicted in Mud Slough and the lower reaches of Artesian Slough. The primary reason for the change in salinity is believed to be the increased tidal prism in Coyote Creek which leads to additional transport of salt mass into Coyote Creek during flood tides.

6.2 Long Term Hydrodynamic Modeling

In this section the predicted hydrodynamic effects of breaching the levees of the island ponds are discussed. When the island pond levees are breache the tidal hydrodynamics in the Alviso Region will change due to increased tidal prism in Coyote Creek downstream of the island ponds. Related hydrodynamic effects include changes to tidal elevations and tidal velocities in the Alviso Region. The changes in tidal velocities may result in channel scour.

Sediment transport and morphology simulations have not been performed. However, the results of the predicted hydrodynamic effects can be interpreted to provide insight to potential changes in morphology that may result from the levee breaches. Overall the island ponds are expected to act as sediment sinks until marshplain elevations evolve in the ponds. Therefore, breaching the island pond levees is likely to cause erosion, particularly in areas where the tidal velocities increase as a result of the levee breaches. However, some of these regions are currently depositional environments and might not erode, but, instead, may become less depositional as a result of the levee breaches.

The model inputs and setup for the Long Term Breach hydrodynamic modeling are discussed the same as the Long Term Breach salinity simulation. Limitations to the accuracy of the simulations were discussed in Section 5. The primary uncertainty that may affect the predicted hydrodynamic effects of the levee breaches is the assumed breach geometry for each breach. It should also be noted that the model bathymetry is based on existing conditions and, therefore, does not account for morphologic changes that may result in the Alviso Region from the levee breaches.

Predicted tidal elevation, tidal prism and tidal velocity changes resulting from the levee breaches are discussed in Sections 6.2.1 through 6.2.3. In Section 6.2.4 the breach geometry is discussed. Potential scour in the channel at the South Pacific Railroad bridge cross-section due to increased tidal prism is predicted based on conservative assumptions in Section 6.2.5.

Two conservative assumptions that are inherent in this analysis make it likely to overestimate hydrodynamic effects in the Alviso Region. The Long Term Breach scenario simulation assumes that the pond bottom elevation under long term conditions is equal to the current pond bottom elevation. The assumed breach geometry is large enough to allow a full tidal range in the island ponds. The combination of these assumptions results in the maximum possible tidal prism in the island ponds. Therefore, the predicted hydrodynamic effects discussed in this section are likely to be larger than the actual hydrodynamic effects that will occur. However, due to sizeable model assumptions and uncertainties, these predictions should not be considered as a worst-case estimate. Some hydrodynamic effects of the breaches could be greater than the predicted effects.

The simulation for the analysis of hydrodynamic effects of the breaches is performed for a one month period from 6/7/1994 to 7/7/1994 . The tidal elevation near Calaveras Point during this period is shown in Figure 6.2-1. As seen in this figure, the tidal elevation at Calaveras Point exhibits diurnal inequality such that the higher high water is typically noteably larger than the lower high water.

6.2.1 Tidal Elevation Analysis

The proposed island pond breaches may influence water surface elevations in the Alviso Region. Changes in water surface elevation may be ecologically relevant because they affect inundation duration and frequency in tidal marsh areas.

The predicted water surface elevations at the center of ponds Alviso A19, Alviso A20, and Alviso A21 are plotted with the predicted water surface elevation in Coyote Creek near Alviso A19 and near Alviso A21 in Figure 6.2.1-1. The predicted water surface elevation in each of the ponds rises rapidly during the incoming tide and then drops more gradually as the pond drains. The predicted water surface elevations shown here reflect the elevation in the center of the pond and do not reflect water levels in the borrow ditches. The predicted water surface elevation in the ponds does not drop as low as in Coyote Creek because the water surface elevation in the ponds cannot fall below the pond bottom elevation. As seen in this figure, the ponds are wet during relatively short intervals. When the pond elevations are constant (at the pond bottom elevation) the ponds have drained into the borrow ditches. The predicted water level in the borrow ditches rises similarly to that in the ponds but drains over a longer period during falling (ebb) tides because the borrow ditches are deeper than the adjacent ponds. The borrow ditches in all three ponds remain partially full through each tidal cycle.

Figure 6.2.1-2 shows the predicted water surface elevation in Coyote Creek near pond Alviso A17 (upstream of the UPRR crossing) for existing conditions and the Long Term Breach scenario. As seen in this figure, breaching the island ponds has a noticeable effect on predicted water levels in Coyote Creek throughout the tidal cycle. During the high tides the predicted water levels are reduced due to the filling of the ponds. During low tides, the predicted water levels are higher because the ponds are draining into Coyote Creek during these periods.

The centerline of Coyote Creek is defined by the stations shown in Figure 5.1-14. Figures 6.2.1-3 to 6.2.1-8 show the predicted tidal elevation in Coyote Creek for existing conditions and the Long Term Breach scenario at several stations in Coyote Creek. The tidal elevation results are summarized in Table 6.2.1-1. As seen in figures and the table, the predicted high water tidal elevations are similar downstream of the island ponds (channel stations 1 km to 5 km) under existing conditions. At the 9 km station and the 11 kilometer station the predicted high water tidal elevations are appreciably diminished relative to the downstream high water tidal elevations.

The mean tidal elevation for existing conditions increases with distance upstream because Coyote Creek becomes shallower with distance upstream and, for this reason, as well as water draining from Warm Springs Marsh, it does not drain completely down to the low water elevations in SSFB. However, in the portion of Coyote Creek upstream of the junction with Artesian Slough, the model results are expected to have limited accuracy due to limited model resolution. The narrow low flow channel geometry in this region can only be represented approximately on the 25 meter resolution grid. Because the deepest part of the channel is not captured on the 25 meter grid, this upstream reach of

Coyote Creek may not drain to the actual low water elevations. The attenuation of high water elevations may also be overestimated due to the limited model resolution in the portion of Coyote Creek upstream of the junction with Artesian Slough. In general, it is believed that the model results underestimate the tidal range in Coyote Creek and that the error increases with distance upstream.

The levee breaches result in minimal changes in predicted tidal elevations at the 1 km and 3 km stations, as shown in Figures 6.2.1-3 and 6.2.1-4. At the 5 km and 7 km stations the levee breaches result in decreases in predicted high water elevations and increases in predicted low water elevations, as shown in Figures 6.2.1-5 and 6.2.1-6. Mean high water decreases by 0.1 ft at the 5 km station and 0.4 ft at the 7 km station while the low water elevations increase by 0.2 to 0.7 ft. The decrease in tidal elevation at high water is a result of the filling of the island ponds near high water, while the increase in elevation at low tide is a result of the draining of the island ponds near low water. At the 9 km and 11 km stations, the predicted high water elevations are decreased by the levee breaches by 0.1 to 0.6 ft but the predicted low water elevations do not change significantly, as shown in Figures 6.2.1-7 and 6.2.1-8.

The minimal changes in predicted tidal elevations at the 1 km and 3 km stations may be partially attributed to the influence of the tidal boundary condition at Calaveras Point, which assumes that the breaches do not affect the tides at the tidal boundary. Although it is unlikely that large changes in tides would occur at these locations, it is likely that the actual changes at these stations would be greater than the predicted changes.

Table 6.2.1-1 Predicted Tidal Elevations at Channel Stations in Coyote Creek for Existing Conditions and the Long Term Breach Scenario

Channel Station Name	Mean Higher High Water [ft NGVD]		Mean High Water [ft NGVD]		Mean Tide Level* [ft NGVD]	
	Existing	Breach	Existing	Breach	Existing	Breach
1 km	4.54	4.52	3.74	3.73	0.94	0.96
3 km	4.51	4.45	3.73	3.67	1.10	1.18
5 km	4.49	4.36	3.72	3.61	1.26	1.39
7 km	4.32	3.89	3.58	3.20	1.38	1.46
9 km	3.98	3.38	3.22	2.75	1.88	1.66*
11 km	3.25	2.92	2.64	2.41	1.86	1.77*

* The expected accuracy of the predicted Mean Tide Level is limited at these locations due to imperfect resolution of the thalweg on the 25 meter resolution grid which leads to incomplete draining at low water.

Figure 6.2.1-5 shows the predicted tidal elevation at the 5 km station. In this region of Coyote Creek, predicted tidal elevation under the Long Term Breach scenario is approximately 0.1 ft lower at high water, 0.2 ft higher at higher low tide, and 0.6 ft higher at lower low tide than the predicted tidal elevation under existing conditions. The predicted tidal elevations for existing conditions and the Long Term Breach scenario at the 7 km station, located adjacent to Alviso A20, are shown in Figure 6.2.1-6. At the 7 km station, the predicted tidal elevation under the Long Term Breach scenario is approximately 0.1 to 0.5 ft lower at high water, 0.25 to 0.4 ft higher at higher low tide, and 0.5 to 0.7 ft higher at lower low tide than the predicted tidal elevation under existing conditions. At the 5 and 7 km stations, the decrease in tidal elevation at high water is a result of the filling of the island ponds during high water, while the increase in elevation at low tide is a result of the draining of the island ponds at low tide. At both the 5 km station and the 7 km station a decreased tidal range is predicted for the Long Term Breach scenario.

The predicted tidal elevations for existing conditions and the Long Term Breach scenario at the 9 and 11 km stations, located upstream of the island pond levee breaches, are shown in Figure 6.2.1-7 and Figure 6.2.1-8, respectively. As seen in these figures, the predicted tidal elevation at low tide is nearly identical for existing conditions and the Long Term Breach scenario. At high water, the predicted tidal elevation for the Long Term Breach scenario is typically 0.15 to 0.6 ft less than under existing conditions. These two figures show that upstream of the island pond breaches, the tidal range in Coyote Creek for the Long Term Breach scenario is somewhat smaller than under existing conditions and that the small decrease in tidal elevation typically occurs at high water. At the 11 km station, located near the entrance of Warm Springs Marsh, the predicted tidal range is 0.5 to 4.25 ft NGVD under existing conditions and 0.5 to 3.75 ft NGVD under the Long Term Breach scenario for the simulation period.

Based on the Long Term Breach scenario results, it is expected that the breaches would affect the tides in Coyote Creek and that the effects would vary by location. Adjacent to the island ponds the predicted tidal range decreased and both low water and high water elevations were affected. Downstream of the island ponds the predicted tidal range changed only slightly by increasing the elevation at low water. Upstream of the island ponds the predicted tidal range decreased slightly due to decreased high water elevations.

6.2.2 Tidal Prism Analysis

The filling of the island ponds during flood tides and the draining of the island ponds during ebb tides also influences the tidal prism of Coyote Creek. The changes in predicted tidal prism in Coyote Creek for the Long Term Breach scenario simulation are discussed in this section.

The predicted volume flux through each of the nine cross-sections shown in Figure 6.2.2-1 and at each of the five levee breaches has been calculated. From these fluxes, the predicted tidal prism is calculated for each of the nine sections and for each of the three ponds. The predicted tidal prism is computed as the net volume flux of the incoming (flood) tide through the section during the incoming tide. Therefore, the tidal prism at a cross-section represents the total volume of inflow that crosses through the section on the incoming tide. For Alviso A20 the predicted tidal prism is computed as the volume of water that enters the pond through the single breach during the incoming tide. For Alviso A21 and Alviso A19 the predicted tidal prism is computed as the net volume of water that enters the pond through the two breaches during the incoming tide.

Table 6.2.2-1 gives the mean, standard deviation and maximum predicted tidal prism for the nine cross-sections and three island ponds.

Table 6.2.2-1 Maximum, Mean, and Standard Deviation of Predicted Tidal Prism for Period from 6/7/94 through 7/7/94 for Existing Conditions and the Long Term Breach Scenario

Cross-section Name	Mean Tidal Prism [acre-feet]		Standard Deviation Tidal Prism [acre-feet]		Maximum Tidal Prism [acre-feet]	
	Existing	Breach	Existing	Breach	Existing	Breach
Calaveras Point	7977	7995	2043	2212	12083	12357
Coyote at Alviso	3189	3423	989	1182	5208	5735
Coyote at Mud	1228	1737	473	699	2195	3079
Railroad Crossing	981	1318	409	537	1763	2321
Coyote at A19	482	477	245	231	989	931
Artesian Slough	301	229	97	76	481	371
Mud Slough Mouth	325	309	153	149	624	605
Middle Mud Slough	185	185	94	96	366	371
Upper Mud Slough	144	152	73	77	286	299
Pond A21	-	290	-	120	-	514
Pond A20	-	151	-	49	-	237
Pond A19	-	468	-	203	-	829

As seen in Table 6.2.2-1, the mean predicted tidal prism through the Coyote at Alviso, Coyote at Mud, Railroad Crossing, and Upper Mud Slough cross-sections increases under the Long Term Breach scenario. The mean predicted tidal prism decreases at the Coyote at A19, Artesian Slough, and Mud Slough Mouth cross-sections. A small to negligible change is observed in the predicted tidal prism at the Calaveras Point, and Middle Mud Slough cross-sections.

The mean predicted tidal prism for ponds Alviso A21, Alviso A20, and Alviso A19 show that the mean volume of water entering the three island ponds is considerable relative to the predicted tidal prism at the Coyote at Mud, Railroad Crossing, Coyote at A19 and Artesian Slough cross-sections. The size of the predicted tidal prisms in the island ponds relative to the predicted tidal prism of the surrounding reaches suggests that the filling and emptying of these ponds will have an influence on tidal flows in the region of Coyote Creek adjacent to the levee breaches.

The standard deviation of the mean predicted tidal prism is as much as 50% of the mean in some cross-sections. This large standard deviation occurs because there is a large diurnal component in the tidal cycle in San Francisco Bay (e.g., higher high water is often considerably higher than lower high water), as seen in Figure 6.2-1. The maximum predicted tidal prism is more than 50% larger than the mean value for both existing conditions and the Long Term Breach scenario.

The tidal prism in the island ponds is generally larger in the flood tide preceding higher high water than during the flood tide preceding lower high water. As a result, changes in tidal prism and tidal velocity resulting from the island pond breaches are larger in the flood tide preceding higher high water than during the flood tide preceding lower high water. Because strong tides are morphologically more important than average tides (e.g. Williams et al., 2002), this measure of tidal prism is particularly useful. This tidal prism will be referred to as the higher high water tidal prism and will be used in the analysis of breach geometry in Section 6.2.5. The mean and standard deviation of the higher high water tidal prism predicted for each cross-section during the period from 6/7/1994 through 7/7/94 are shown in Table 6.2.2-2.

Table 6.2.2-2 Mean and Standard Deviation of Higher High Water Tidal Prism for Period from 6/7/94 through 7/7/94 for Existing Conditions and the Long Term Breach Scenario

Cross-section Name	Mean Higher High Water Tidal Prism [acre-feet]		Standard Deviation Higher High Water Tidal Prism [acre-feet]	
	Existing	Breach	Existing	Breach
Calaveras Point	9578	9778	1277	1341
Coyote at Alviso	4033	4458	600	677
Coyote at Mud	1606	2310	309	426
Railroad Crossing	1298	1760	258	318
Coyote at A19	681	666	165	148
Artesian Slough	383	295	53	41
Mud Slough Mouth	450	431	95	93
Middle Mud Slough	263	265	57	58
Upper Mud Slough	205	216	44	46
Pond A21	-	392	-	67
Pond A20	-	193	-	25
Pond A19	-	636	-	113

As seen in Table 6.2.2-2, the mean higher high water tidal prism predicted for each of the nine reaches and three ponds is higher than the mean predicted tidal prisms shown in Table 6.2.2-1 for both existing conditions and the Long Term Breach scenario. The greatest increases in the mean higher high water predicted tidal prism occur in the Coyote at Alviso, Coyote at Mud, and Railroad Crossing cross-sections. The greatest decrease in the mean higher high water predicted tidal prism occurs in the Artesian Slough cross-section.

The standard deviation of the higher high water predicted tidal prism is much smaller than that computed for the mean predicted tidal prism. The large standard deviation of the mean predicted tidal prism is a result of the large diurnal inequality in SSFB.

In conclusion, it is expected that the levee breaches will result in increased tidal prism in regions of Coyote Creek located adjacent to the levee breaches and downstream of the levee breaches. The regions adjacent to the levee breaches experience the largest predicted increases in tidal prism while, in the regions downstream of the levee breaches, the predicted increases are smaller. Upstream of the levee breaches in portions of Coyote Creek and Artesian Slough, the predicted tidal prism decreases.

6.2.3 Velocity Analysis

Analysis of the effects of the island pond breaches on predicted tidal velocities in the Alviso Region provides insight to potential changes in erosion and deposition patterns. For example, erosion may occur in regions with increased tidal velocities due to the levee breaches. Higher tidal velocities are associated with more vigorous vertical and horizontal transport and mixing.

The Alviso Region model contains approximately 225,000 active cells. In order to better visualize and interpret the large amount of data generated by the model, it is useful to compute spatial averages. In this section, both cross-sectional average velocities and depth-averaged velocities are analyzed, and the statistical properties (e.g., averages) of these velocities are presented. The cross-sectional average velocities can be easily graphed while the spatial distribution of depth-averaged velocities can be shown as maps.

The predicted cross-sectional average velocity has been computed at each of the nine cross-sections shown in Figure 6.2.2-1 and at each of the five levee breaches. For each day during the period from 6/7/94 through 7/7/94 the daily maximum predicted cross-sectional average velocity magnitude is computed at each of the nine sections and five breaches. From these daily maximum predicted cross-sectional average velocities, the mean daily peak predicted cross-sectional average velocity magnitude, the standard deviation of the daily peak predicted cross-sectional average velocity magnitude, and the overall maximum predicted cross-sectional average velocity magnitude is computed at the 14 locations for both existing conditions and the Long Term Breach scenario. These values are shown in Table 6.2.3-1.

Table 6.2.3-1 Maximum, Mean, and Standard Deviation of Daily Peak Predicted Cross-Sectional Velocity Magnitude for Period from 6/7/94 through 7/7/94 for Existing Conditions and the Long Term Breach Scenario

Cross-Section Name	Mean Daily Peak Cross-sectional Velocity [ft/s]		Standard Deviation Daily Peak Cross-sectional Velocity [ft/s]		Maximum Cross-sectional Velocity [ft/s]	
	Existing	Breach	Existing	Breach	Existing	Breach
Calaveras Point	1.15	1.22	0.11	0.14	1.36	1.46
Coyote at Alviso	1.25	1.32	0.12	0.07	1.45	1.45
Coyote at Mud	1.28	1.78	0.10	0.12	1.43	1.98
Railroad Crossing	1.25	1.59	0.09	0.10	1.38	1.77
Coyote at A19	1.54	1.64	0.12	0.18	1.75	1.98
Artesian Slough	0.90	0.69	0.08	0.06	1.02	0.77
Mud Slough Mouth	1.73	1.62	0.13	0.10	1.93	1.82
Middle Mud Slough	2.06	1.99	0.17	0.17	2.32	2.27
Upper Mud Slough	2.35	2.40	0.21	0.23	2.82	2.86
A21 DS Breach	-	3.46	-	0.33	-	3.99
A21 US Breach	-	1.57	-	0.13	-	1.79
A20 Breach	-	1.91	-	0.18	-	2.21
A19 DS Breach	-	3.86	-	0.43	-	4.54
A19 US Breach	-	2.12	-	0.30	-	2.56

As seen in Table 6.2.3-1, the mean daily peak predicted cross-sectional average velocity magnitude increases at the Calaveras Point, Coyote at Alviso, Coyote at Mud, Railroad Crossing, Coyote at A19, and Upper Mud Slough cross-sections for the Long Term Breach scenario. The greatest predicted increases occur in the Coyote at Mud and Railroad Crossing cross-sections which are located closest to the levee breaches. The mean cross-sectional average velocity magnitude decreases for the Artesian Slough, Mud Slough Mouth, and Middle Mud Slough cross-sections.

As seen in Table 6.2.3-1, the maximum predicted cross-sectional average velocity magnitude that occurs for the period from 6/7/94 through 7/7/94 typically increases in sections where the mean daily peak increases. However in the Coyote at Alviso cross-section the maximum predicted cross-sectional average velocity magnitude remains unchanged. The greatest increases in maximum predicted velocity magnitude occur in the Coyote at Mud and Railroad Crossing cross-sections, which are located closest to the levee breaches.

Figure 6.2.3-1 shows the predicted cross-sectional average velocity at the Coyote at Mud cross-section in Coyote Creek under existing conditions and the Long Term Breach scenario. The predicted cross-sectional average velocity at the Railroad Crossing cross-section in Coyote Creek under existing and breach conditions is shown in Figure 6.2.3-2.

In these figures, a positive velocity indicates flow into Coyote Creek and a negative velocity indicates flow out of Coyote Creek. The locations of these cross-sections are shown on Figure 6.2-2. Breaching the island ponds results in an increased magnitude in predicted cross-sectional average velocities in both of these sections during both the incoming and outgoing tides. The peak predicted cross-sectional average velocity magnitude increases by about 0.5 ft/s.

In addition to the cross-section velocities discussed above, the depth-averaged velocity throughout the Alviso Region is computed. Using a representative day (6/7/1994) from the month long simulation, the daily RMS and maximum and velocity is predicted at each horizontal location in the model grid.

RMS Velocity

For this analysis, the predicted depth-averaged velocities that occur on 6/7/94 are evaluated. The predicted RMS velocities over the model domain on 6/7/94 for existing conditions and the Long Term Breach scenario are compared.

The RMS velocity gives a weighted average of the velocity magnitude that occurs at each cell. The predicted RMS velocities for existing conditions and the Long Term Breach scenario are shown in Figure 6.2.3-3. The magnitude change in predicted RMS velocity resulting from the levee breaches is shown in Figure 6.2.3-4.

These results show that the effect of the levee breach is largely confined to the section of Coyote Creek adjacent to the breaches. For the majority of the model domain, the Long Term Breach scenario results in less than a 0.1 ft/s change in predicted RMS velocity. The greatest increases in predicted RMS velocity occur between the mouth of Mud Slough and the Alviso A19 breach. Upstream of the Alviso A19 breach, the predicted RMS velocities in Coyote Creek and Artesian Slough are reduced under the Long Term Breach scenario.

Maximum Velocity

During the each day of the simulation period, the maximum predicted depth-averaged velocity magnitude for each water column is computed. The maximum predicted depth-averaged velocities for existing conditions and the Long Term Breach scenario on 6/7/1994 are shown in Figure 6.2.3-5. The changes in maximum predicted depth-averaged velocity magnitude resulting from the levee breach are shown in Figure 6.2.3-6.

The comparison of maximum predicted depth-averaged velocity magnitude in the Alviso Region also shows that the effect of the levee breach is largely confined to the section of Coyote Creek adjacent to the breaches. For the majority of the model domain, the levee breaches result in less than a 0.1 ft/s change in maximum velocity magnitude. Maximum predicted velocity magnitude increases of 0.1 to 0.2 ft/s are typically seen in the channel of Coyote Creek with larger increases seen immediately adjacent to the levee breaches.

Upstream of the Alviso A19 breach, the maximum predicted depth-averaged velocities in Coyote Creek and Artesian Slough are reduced under the Long Term Breach scenario.

In conclusion, the levee breaches may result in considerably increased tidal velocities in regions of Coyote Creek located adjacent to the levee breaches and smaller increases downstream of the levee breaches. The tidal velocities are expected to decrease upstream of the levee breaches and in Artesian Slough, Mud Slough and the Warm Springs Marsh area as a result of the levee breaches.

6.2.4 Breach Geometry Analysis

The geometry of the breaches will have some effect on the results of the hydrodynamic analyses discussed in the previous sections. Although there is sizeable uncertainty in the evolution of the breach geometry, the assumed breach geometry used in the Long Term Breach hydrodynamic analysis is conservative because it allows a full tidal range in the island ponds. Figure 6.2.4-1 (ADD FIGURE) shows that the predicted range of elevations in the ponds is approximately equal to the predicted range of elevations in the bordering regions of Coyote Creek. Therefore the assumed breach geometry allows the island ponds to experience approximately the maximum possible tidal prism.

The proposed constructed breaches will initially be shallow. Over time the breaches are expected to erode, becoming both deeper and wider than the constructed breaches. During this period it is also likely that sediment will deposit in the island ponds and that they will approach marshplain elevation, thereby reducing tidal prism in the ponds. In the analysis of hydrodynamic effects resulting from breaching the island ponds, deposition in the island ponds was neglected. Therefore, the largest possible changes in tidal hydrodynamics were computed by assuming that the breaches erode to have a large enough cross-sectional area to allow the island ponds to experience a full tidal range, while the pond bottom elevation remains relatively stable. Based on observations in Warm Springs Marsh (Williams et al., 2002), it is more likely that the breaches will erode slowly and that considerable deposition will occur in the island ponds before the breach geometry reaches an equilibrium morphology. This more realistic evolution would result in smaller changes in the hydrodynamics of Coyote Creek than those estimated in this study.

Because breach erosion will occur simultaneously with deposition in the ponds, it is difficult to accurately estimate the equilibrium breach geometry that will result for each breach. However, it is possible to estimate the largest possible breach geometry that could evolve by assuming that the breaches erode and that no deposition occurs within the ponds. In the following analysis the breach geometry is examined using two methods. In the first, the adequacy of tidal velocities through the breaches to assure breach stability is evaluated. In the second, the equilibrium breach size for the computed tidal prism in each pond is estimated.

Goodwin (1996) suggests that one of the simplest means of determining if an inlet is stable is to look at the maximum velocity magnitude through the inlet. According to

Goodwin (1996), for a stable inlet channel the maximum velocity magnitude should be about 1.0 ± 0.15 m/s (3.28 ± 0.5 ft/s). The cross-sectional average velocity computed in the Long Term Breach scenario simulation was analyzed and the average daily maximum velocity as well as the maximum velocity during the entire simulation period are presented in Table 6.2.4-1

At the levee breaches, the mean of the daily peak predicted cross-sectional average velocity magnitude ranges from 1.91 ft/s at the Alviso A20 breach to 3.86 ft/s at the downstream breach in Alviso A19. The overall maximum velocity magnitude through each of the breaches is between 15% and 21% higher than the mean daily peak velocity magnitude. The greatest maximum predicted cross-sectional velocity magnitude observed is 4.54 ft/s at the downstream breach in Alviso A19.

Table 6.2.4-1 Predicted Daily Maximum Cross-Sectional Velocity through each Breach Averaged during the Simulation Period and Predicted Maximum Cross-Sectional Velocity through each Breach During the Simulation Period

Cross-Section Name	Mean Daily Peak Cross-sectional Velocity [ft/s]	Standard Deviation Daily Peak Cross-sectional Velocity [ft/s]	Maximum Cross-sectional Velocity [ft/s]
A21 DS Breach	3.46	0.33	3.99
A21 US Breach	1.57	0.13	1.79
A20 Breach	1.91	0.18	2.21
A19 DS Breach	3.86	0.43	4.54
A19 US Breach	2.12	0.30	2.56

As seen the above table, the maximum velocity magnitude predicted in each of the three breaches ranges from 1.79 to 4.54 ft/s. Based on these velocities, it is expected that the assumed geometry of the A20 breach, the A21 upstream breach and the A19 upstream breach may be too large. It is likely that that the breaches would not widen and deepen to the assumed breach geometry in these locations. The A21 downstream breach and the A19 downstream breach are expected to be stable for the assumed geometry. Given that the maximum predicted velocities at the downstream breach for Alviso A21 and the downstream breach for Alviso A19 exceed the minimum velocity required for stability these breaches may scour to be larger than was assumed.

In the absence of field measurements, the equilibrium area of a stable inlet channel can be approximated by (Goodwin, 1996)

$$A_c = \alpha\Omega^{\beta} \qquad \text{(Equation 6.2.4-1)}$$

where A_c is the equilibrium cross-sectional area of the inlet channel, Ω is the tidal prism, and α and β are regression coefficients. A set of coefficients for this relationship are given by Williams et al. (2002) based on the analysis of channel geometry in several tidal marshes in San Francisco Bay. Williams et al. (2002) estimate the coefficients to be α = 0.00284 and β = 0.649, where Ω is the "potential diurnal tidal prism" in cubic meters and A_c is the cross-sectional area in square meters below MHHW. The "potential diurnal tidal prism" is defined by Williams et al. (2002) as the "volume of water upstream of a cross-section between the elevations of mean lower low water (MLLW) and MHHW.

The mean tidal prism of the flood tide preceding higher high water is given for each of the island ponds in Table 6.2.2-2. This tidal prism is the average volume that passes a cross-section during the flood tide preceding higher high water and is comparable in magnitude to the "potential diurnal tidal prism." Using the predicted mean higher high water tidal prism from the long term hydrodynamic simulation, the maximum equilibrium cross-sectional area was computed for each pond using Equation 6.2.4-1. It should be noted that, unlike the previous stability analysis for each breach, this analysis of tidal prism is applied to each pond, not each individual breach, to determine the maximum total cross-sectional breach area for each pond.

Table 6.2.4-2 Comparison of Assumed Breach Area and Maximum Equilibrium Breach Area below MHHW

Pond Name	MHHW (ft NGVD)	Assumed Breach Area Below MHHW (ft^2)	Maximum Equilibrium Breach Area Below MHHW (ft^2)
Alviso A19	3.56	1,108	2,046
Alviso A20	3.82	571	944
Alviso A21	4.05	1,098	1,494

In all ponds the maximum equilibrium cross-sectional breach area, based on the empirical relationship in Williams et al. (2002), is larger than the assumed breach area. This suggests that, if these breaches erode rapidly relative to the rate of deposition in the island ponds, the breach area would exceed the assumed breach areas. For Alviso A19, the maximum equilibrium cross-sectional breach area is considerably larger than the assumed breach area. However, for all the island ponds it is likely that considerable deposition will occur in the ponds as the breaches evolve and that the maximum equilibrium breach areas shown in Table 6.2.4-2 will not be reached.

The use of the tidal prism to compute the maximum equilibrium cross-sectional area gives somewhat different conclusions than those reached by using the maximum velocity to assess the inlet stability. Both analyses suggest that the downstream breach in Alviso A19 and the downstream breach in Alviso A21 may be larger in cross-sectional area than was assumed. Based on data reported for other marsh restoration project in San Francisco Bay (e.g., Williams et al., 2002 and Takekawa, 2003), it is likely that the breaches will erode slowly over a period of years and that considerable deposition will occur in the island ponds during this period. Therefore, it is likely that the actual breaches will not evolve to be as large as the assumed breaches because deposition of sediment in the island ponds will decrease the tidal prism in these ponds and, in turn, the velocities through the breaches. In any case, even if larger levee breaches do evolve, it is unlikely that the increased breach size would lead to larger hydrodynamic effects than those predicted in the preceding sections, because the assumed breaches allow full tidal range and approximately maximum tidal prism in the island ponds.

6.2.5 Railroad Cross-Section Scour Analysis

The potential for scour at the railroad crossing cross-section, located between Alviso A21 and Alviso A20, under the Long Term Breach scenario is of particular interest due to presence of a Southern Pacific Railroad bridge at this location. In this analysis the hydrodynamic model results are analyzed to predict the potential depth of scour that could result from the levee breaches. In the following section the degree of scour in the railroad cross-section is estimated based on the increase in tidal prism resulting from the island pond levee breaches.

If the portion of Coyote Creek near the railroad cross-section is currently a depositional environment, it is possible that tidal velocities and tidal prism at the railroad cross-section could increase to some extent without leading to scour. Conversely, the railroad cross-section may erode as a result of the levee breaches even if the tidal velocities do not increase appreciably. The cohesive sediment in South San Francisco Bay is readily resuspended by tidal velocities and wind wave action and transported in SSFB by tidal currents (Schoellhamer, 1996). Therefore, even in locations with no net erosion or accretion, sediments are actively resuspended and deposited. The island ponds are expected to act as a sink of sediment that is resuspended and, therefore, it is likely that the island pond levee breaches would cause net erosion in Coyote Creek. The rate and degree of erosion will depend on sediment properties. Furthermore morphologic changes in other regions of Coyote Creek and inside the island ponds will also affect the hydrodynamics, and, therefore, the degree of scour, near the Southern Pacific Railroad bridge. In order to predict the erosion that would occur due to net transport of sediment into the island ponds, a sediment transport model, and possibly a morphology model, is required. This is beyond the scope of the current analysis.

Instead, a simplified approach is used to predict the degree of scour that may occur near the Southern Pacific Railroad bridge. A hydrodynamic model applied without a sediment transport model or a morphology model. It is assumed that the channel geometry (bathymetry) is in equilibrium with the tidal velocities and, therefore, that larger tidal velocities would lead to scour while smaller tidal velocities would lead to deposition. The change in cross-sectional area that could be caused by scour is estimated for both peak ebb and peak flood velocity. Assuming that the cross-sectional geometry is in equilibrium with the cross-sectional average velocity implies that the cross-sectional area would increase at the Railroad Crossing cross-section until the cross-sectional average velocity for the Long Term Breach scenario is equal to the cross-sectional average velocity for existing conditions.

As seen on Figure 6.2.3-2, the predicted cross-sectional average velocity magnitude at the railroad crossing cross-section is larger under the Long Term Breach scenario than under existing conditions during both the flood tide and the ebb tide. Based on the results for the period from 6/7/1994 through 7/7/1994, it is estimated that during flood tide the cross-sectional area for the Long Term Breach scenario would need to be increased by approximately 20 to 30 percent in order for the peak velocity to be the same as under existing conditions. During ebb tide, the cross-sectional area would also need to be increased by approximately 20 to 30 percent in order for the peak velocity to be the same as under existing conditions.

This increase in cross-sectional area would probably be accomplished by a combination of widening and deepening of the channel. To estimate the potential scour that could occur if this change in area results only in deepening the cross-section, the approximate change in cross-sectional area is divided by the top width of the channel to compute the equivalent scour depth. During flood tide, when the top width of the cross-section is wider than the channel, it is assumed that the scour adjustment occurs only in the channel (not marsh or mudflat areas) and the change in cross-sectional area is divided by the maximum channel width. During flood tide, a depth adjustment of approximately 1.5 to 3 feet would be required in the channel region. Figure 6.2.5-1 shows the existing cross-section and the estimated scour for a 2.5 foot depth adjustment in the channel during flood tide. During ebb tide, a depth adjustment of approximately 1 to 2 feet would be required. Figure 6.2.5-2 shows the existing cross-section and the estimated scour for a 2 foot depth adjustment during ebb tide.

Potential erosion in the higher marsh and mudflat areas of the Coyote Creek cross section was not included in the conservative scour analysis. The potential for erosion in the marsh and mudflat areas is limited by the brief period of inundation at high tide, the low velocities near slack water, the erosion protection due to marsh plants, and the limited depths of water. Because the flow depths are generally less than 2 ft deep in the mudflats at higher high tide, an increase of 20 to 30 percent would generally be less than six inches.

Equation 6.2.4-1 can also be applied to the railroad cross-section. According to this equation the cross-sectional area would increase from 3,251 ft^2 to 3,961 ft^2 as a result of the breaches. Williams et al. (2002) also give an equation for channel depth, which suggest that the channel would scour 0.9 ft as a result of the breaches. This estimate of scour is much lower than the conservative estimate of 1.5 to 3 ft primarily because, in the Williams et al. (2002) equilibrium relationships, channel area increases due to widening and deepening of the channel, while, in the conservative estimate of scour, the channel was assumed to deepen without widening.

7. Summary and Conclusions

The preferred management alternative for the island ponds is to breach the levees of each pond, with one breach in Alviso A20 and two breaches in both Alviso A19 and Alviso A21. The effects of the levee breaches on salinity in the Alviso Region are predicted for both the “initial breach” period immediately following the breaches and the “long term” period in which the breaches are assumed to have a large enough area to allow a full tidal range inside the island ponds. The effects of the levee breaches on the hydrodynamics of the Alviso Region are also predicted for the long term period.

In Section 5 the effects of the levee breaches on salinity in the Alviso Region during the month following the levee breaches are discussed. Prior to breaching the island ponds, the water volume in the ponds will be reduced by transferring the water volume to Cargill plant 2. The maximum initial salinity for the island ponds is 135 ppt. The construction of the pond breaches will be staggered in time. Initially the constructed breaches will be relatively shallow to allow the pond water to mix with bay water before discharging and to allow the island ponds to discharge gradually.

The effect of the breaches on salinity in the Alviso Region during the “initial breach” period following construction of the breaches is predicted for two different breach geometries. In the first scenario, the Breach at Pond Bottom Elevation scenario, each breach is assumed to be at an elevation equal to the pond bottom elevation. Salinity increases of up to 15 ppt are predicted in the channel of Coyote Creek adjacent to the breaches during the first two weeks following the construction of the breaches, but channel salinity generally remains below oceanic salinity. Predicted salinity effects decrease over time but increases of approximately 5 ppt are predicted in the portion of Coyote Creek adjacent to the island ponds one month after the initiation of the levee breaches.

The second scenario, the Breach at 0 ft NGVD, assumes lower breach elevations and, therefore, more rapid release of water from the Island Ponds. This scenario corresponds to the construction of relatively deep breaches or rapid erosion of shallow breaches. Salinity increases of up to 25 ppt are predicted in the channel of Coyote Creek adjacent to the island ponds during the first week following the initiation of the breaches, but channel salinity generally remains below oceanic salinity. The predicted salinity effects decrease over time but increases of up to 7 ppt are predicted in the channel of Coyote Creek adjacent to the island ponds one month after the levees are breached. The predicted salinity increases that are present one month after the pond breaches are constructed are at least partially due to changes in hydrodynamics (tidal prism, velocity, etc.) that result from the levee breaches.

In Section 6.1 a conservative estimate of the long term effects of the levee breaches on Alviso Region salinity is discussed. The scenario simulated assumes that the breaches scour down to the bottom elevation of the borrow ditch in the pond but that the bottom elevations inside the ponds are equivalent to existing elevations. This scenario is conservative because it corresponds to the maximum tidal prism possible in the island ponds. In the Long Term Breach scenario a persistent salinity increase of 3 to 8 ppt is predicted during summer in the channel of Coyote Creek adjacent to the island ponds and in Warm Springs Marsh as a result of the levee breaches. The primary reason for the change in salinity is believed to be the increased tidal prism in Coyote Creek which leads to additional transport of salt mass into Coyote Creek during flood tides.

In Section 6.2 a conservative estimate of the long term effects of the levee breaches on Alviso Region hydrodynamics is discussed. The breach geometry in each pond is identical to the breach geometry for the salinity analysis of the Long Term Breach scenario. Predicted changes in tidal elevation, tidal prism and tidal velocities are discussed in Sections 6.2.1, 6.2.2 and 6.2.3. The largest possible breach geometry of each breach and the potential for scour at the Southern Pacific Railroad crossing are discussed in Sections 6.2.4 and 6.2.5, respectively.

The levee breaches are expected to result in decreased tidal range in Coyote Creek adjacent to the island ponds. Downstream of the island ponds the predicted tidal range changed only slightly by increasing the elevation at low water. Upstream of the island ponds high water elevations decrease slightly.

The levee breaches will result in increased tidal prism in regions of Coyote Creek located adjacent to the levee breaches and downstream of the levee breaches. The regions adjacent to the levee breaches experience the largest predicted increases in tidal prism. Upstream of the levee breaches in portions of Coyote Creek and Artesian Slough the predicted tidal prism decreases.

The levee breaches may result in considerably increased tidal velocities in regions of Coyote Creek located adjacent to the levee breaches and smaller increases downstream of the levee breaches. The tidal velocities are expected to decrease upstream of the levee breaches and in Artesian Slough, Mud Slough and the Warm Springs Marsh area as a result of the levee breaches.

The predicted long term effects of the levee breaches on salinity and tidal hydrodynamics in the Alviso Region are expected to be conservative because the assumed levee breaches are large enough to allow full tidal range, and therefore maximum tidal prism, in the island ponds. The breach geometry and island pond depths specified in this scenario assume that the breach erodes much faster than sedimentation in the ponds. In Section 4.3.5 the largest possible breach area for each breach is estimated based on these assumptions and empirical relationships from Goodwin (1996) and Williams et al. (2002). It is concluded that, if breach erosion occurs much more rapidly than sedimentation in the ponds, some breaches could be larger than was assumed in the simulations. However, based upon data presented by Williams et al. (2002) for Warm Springs and other breached levee salt marshes, significant deposition is expected to occur before an equilibrium channel geometry and breach geometry is reached.

The proposed levee breaches are likely to cause channel scour in Coyote Creek. A conservative estimate of scour at the railroad cross-section is predicted by assuming that the channel area increase is proportional to the predicted velocity increase and that the channel area is increased only by deepening. The thalweg depth is predicted to increase by 2 to 2.5 ft as a result of the levee breaches. However, based on empirical relationships between channel depth and tidal prism (Williams et al., 2002) the channel depth would increase by only 0.9 ft, and channel widening would occur, as a result of the increased tidal prism upstream of this cross-section.

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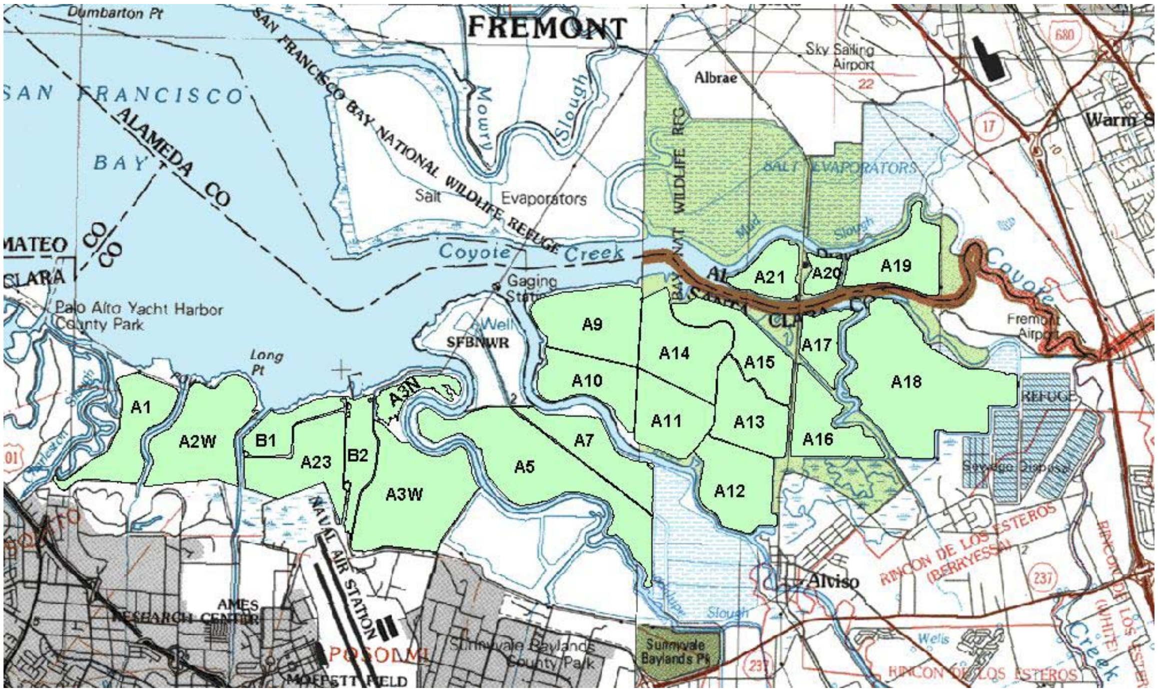


Figure 1-1 Location of Alviso Ponds including the Island Ponds

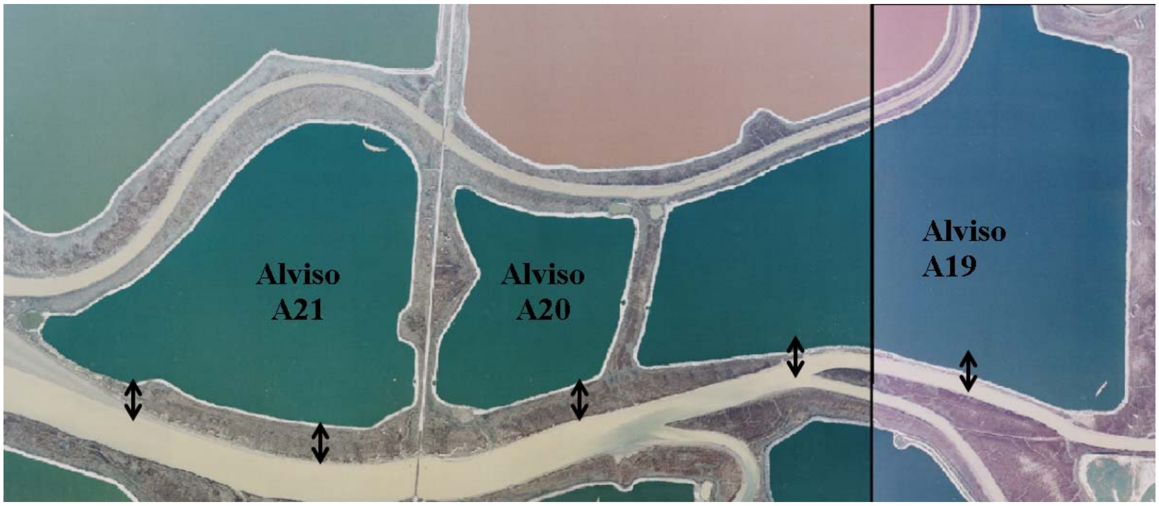


Figure 1-2 Locations of Proposed Island Pond Levee Breaches

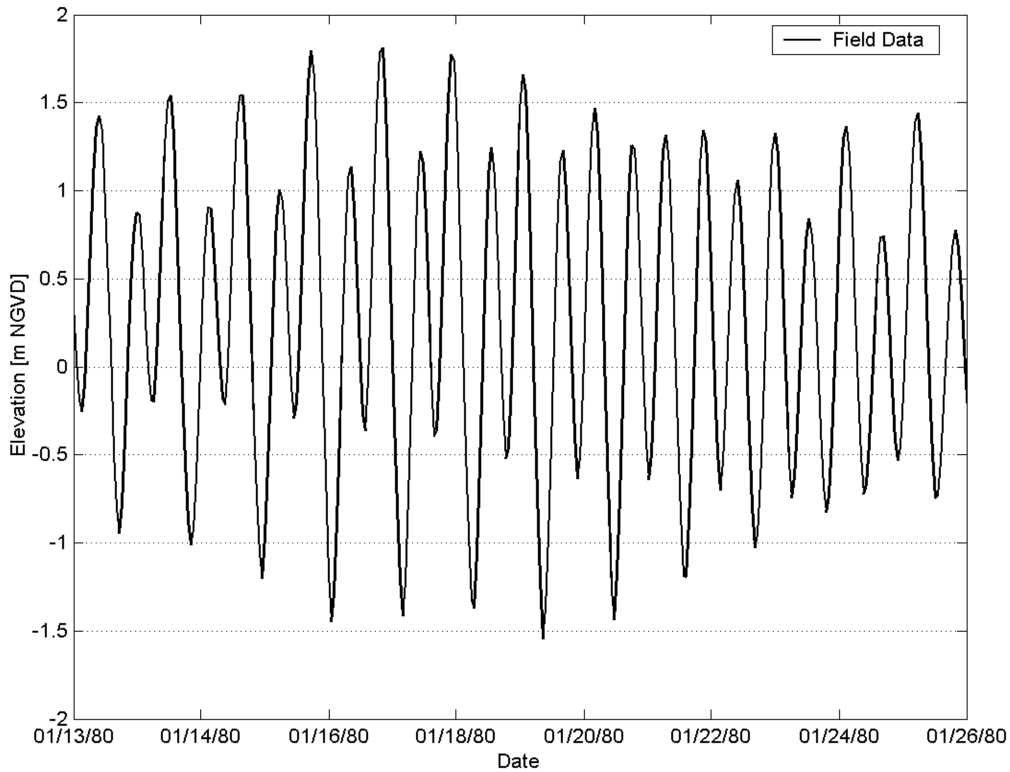


Figure 2-1 Observed water surface elevation at NOAA station 9414509, located at the Dumbarton Bridge

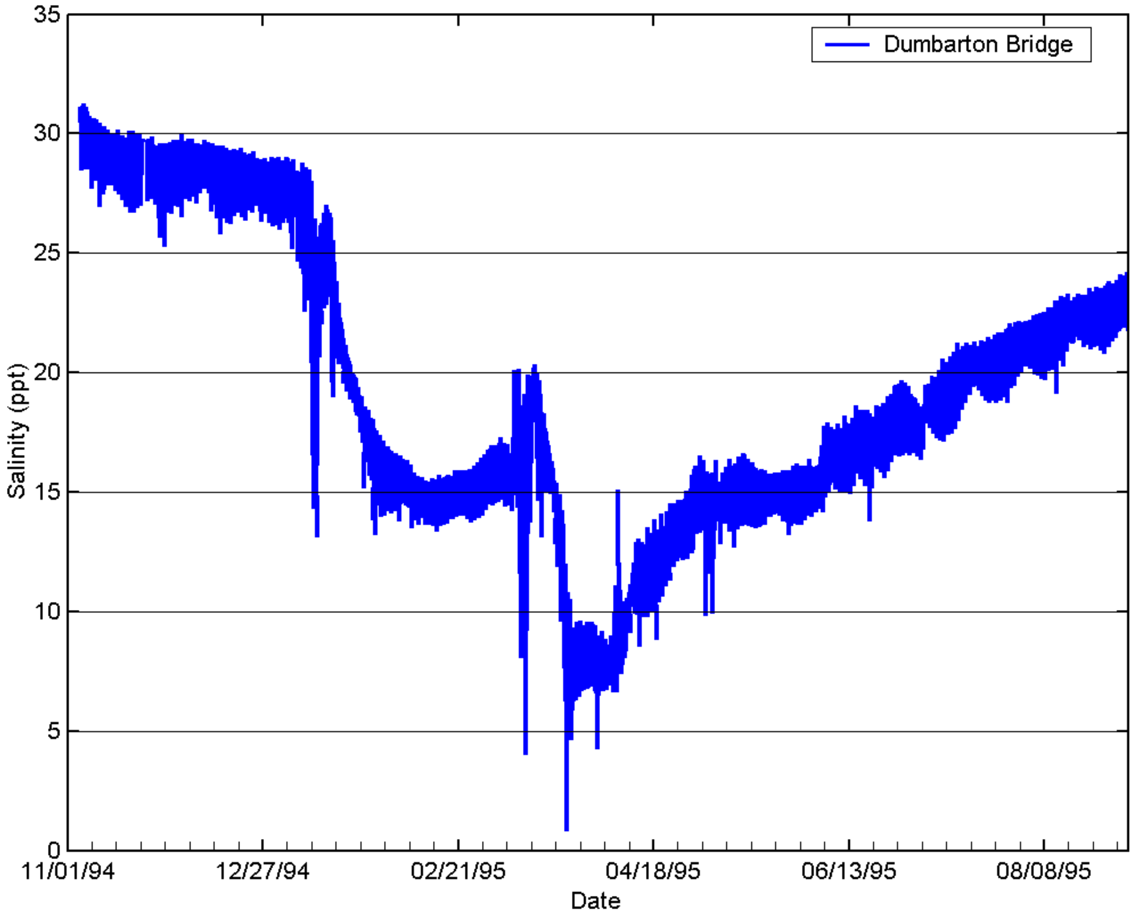


Figure 2-2 Observed salinity near the Dumbarton Bridge

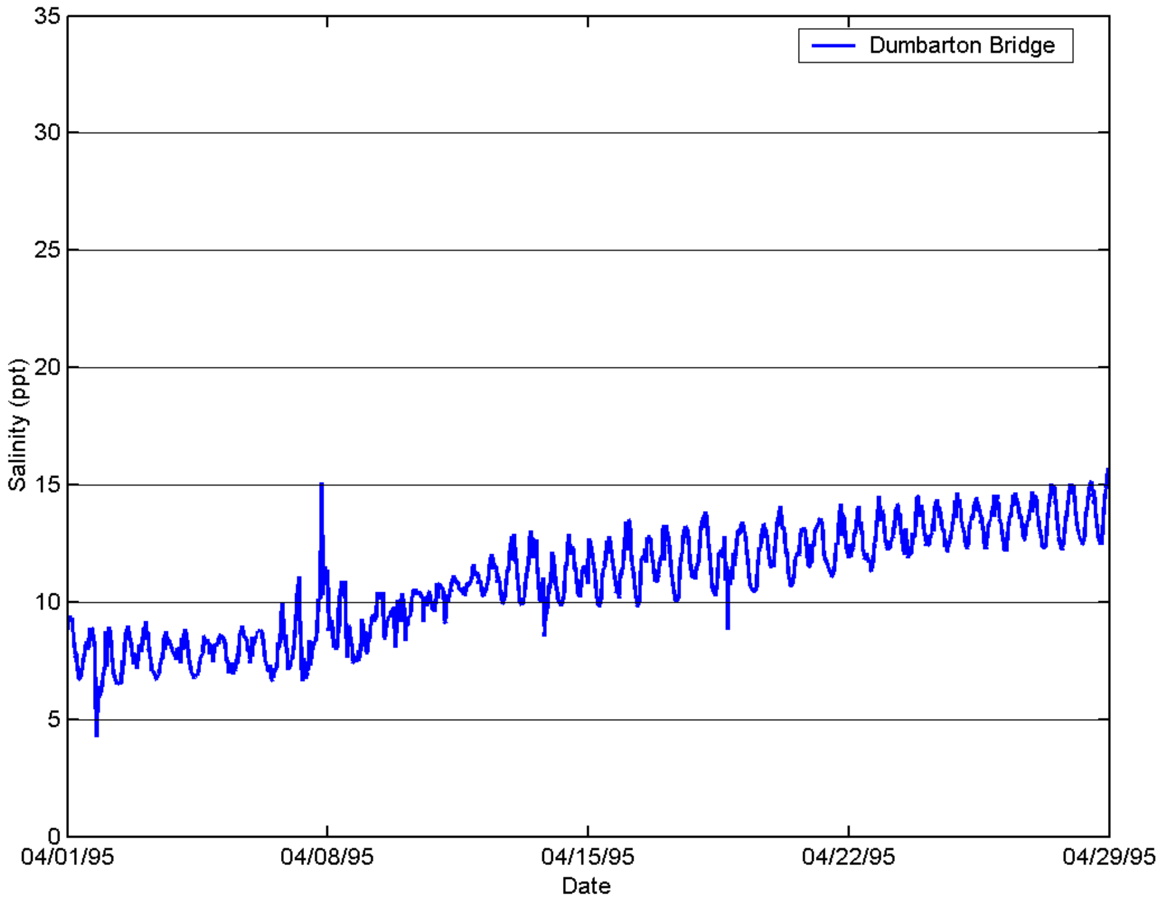


Figure 2-3 Observed salinity near the Dumbarton Bridge during April 1995

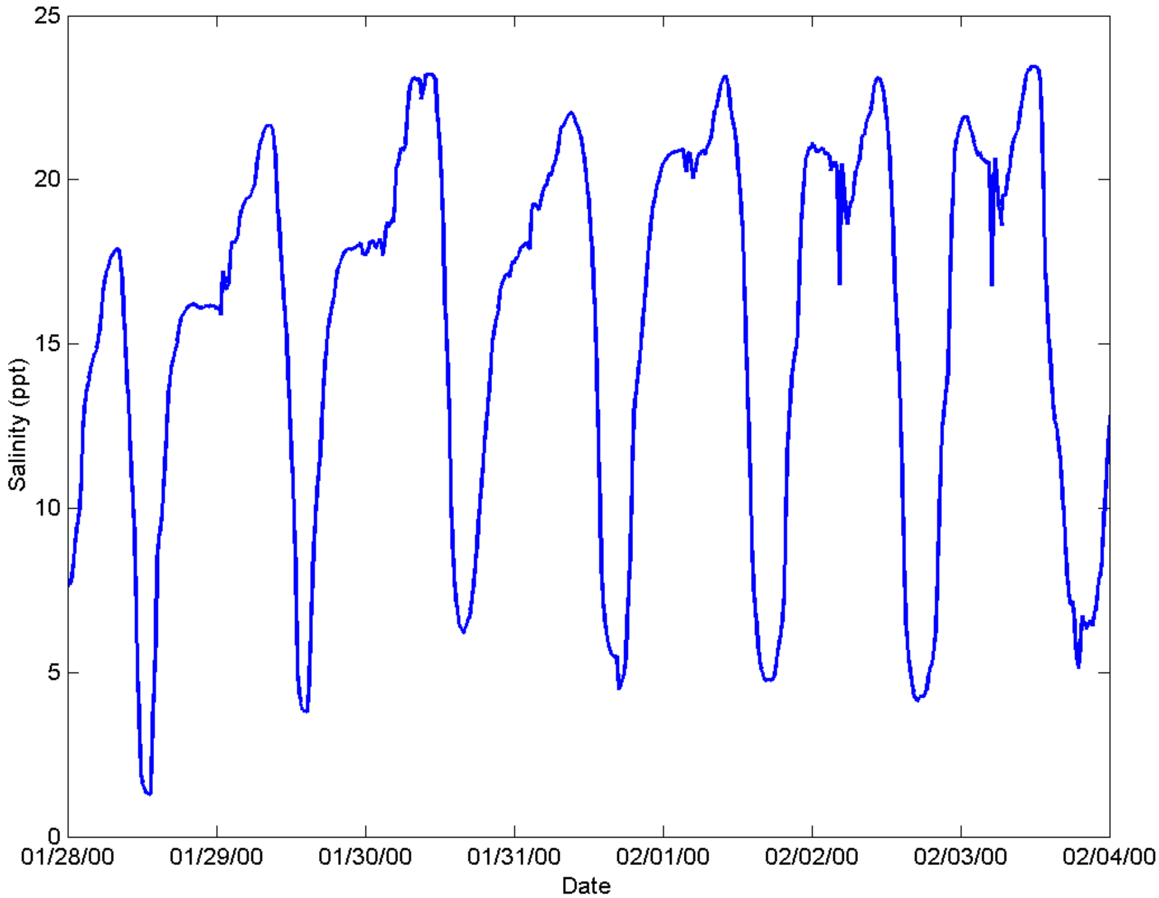


Figure 2-4 Observed bottom sensor salinity in Coyote Creek, near Mud Slough

Figure 4.1.1-1 South San Francisco Bay Model Domain and Bathymetry

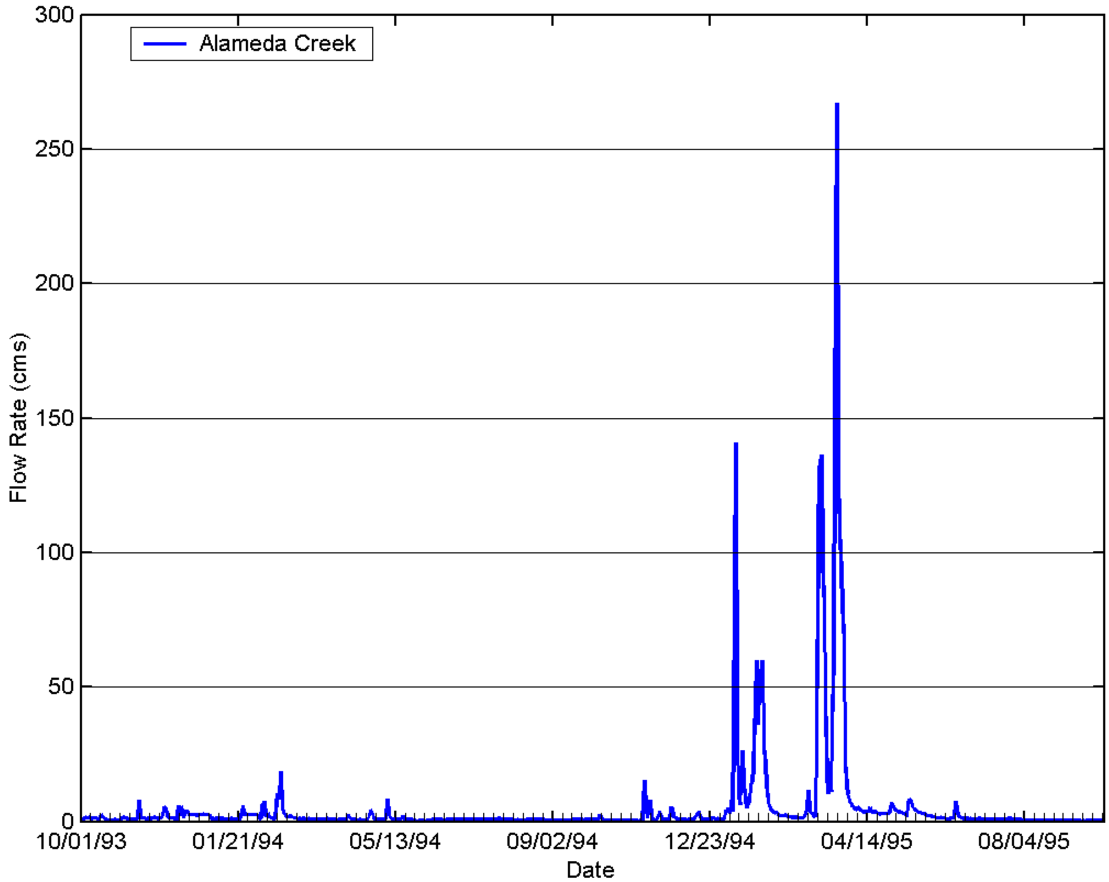


Figure 4.1.2-1 Flow rate from Alameda Creek to Alameda Flood Control Channel

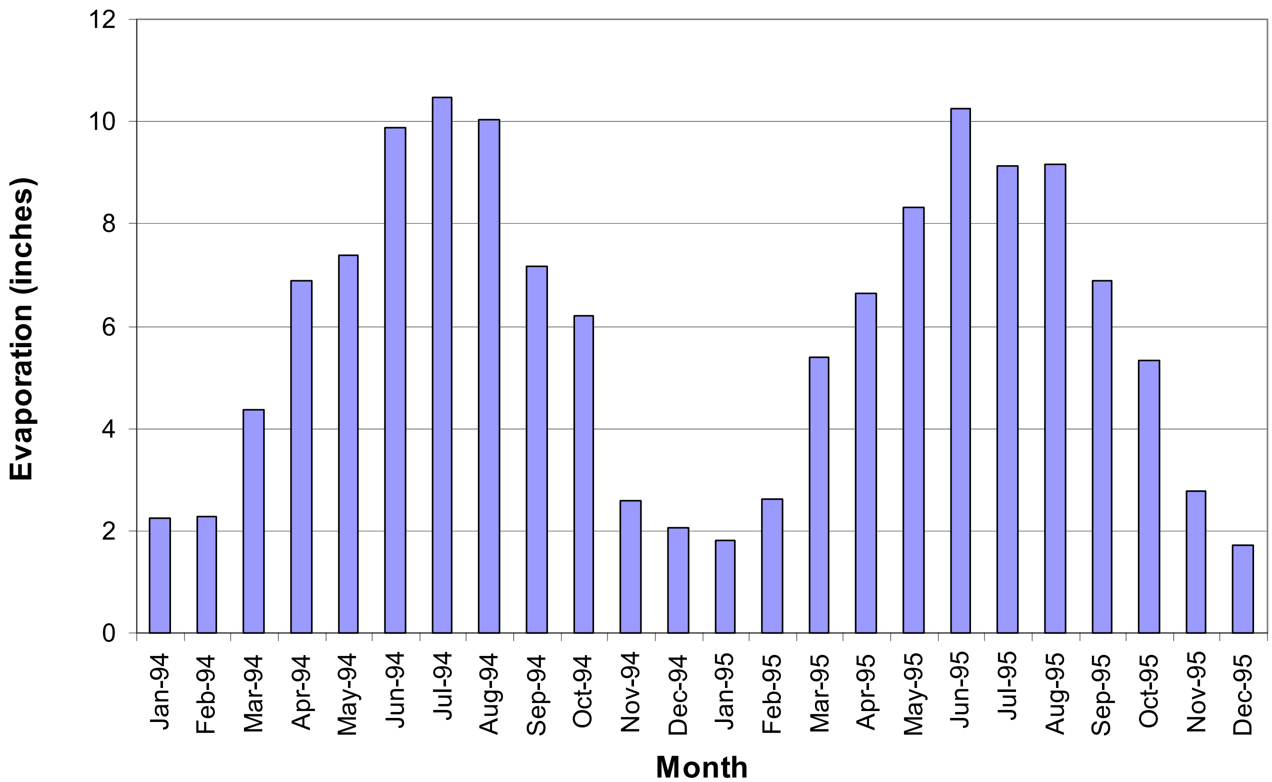


Figure 4.1.4-1 Monthly Pan Evaporation Measured in Newark

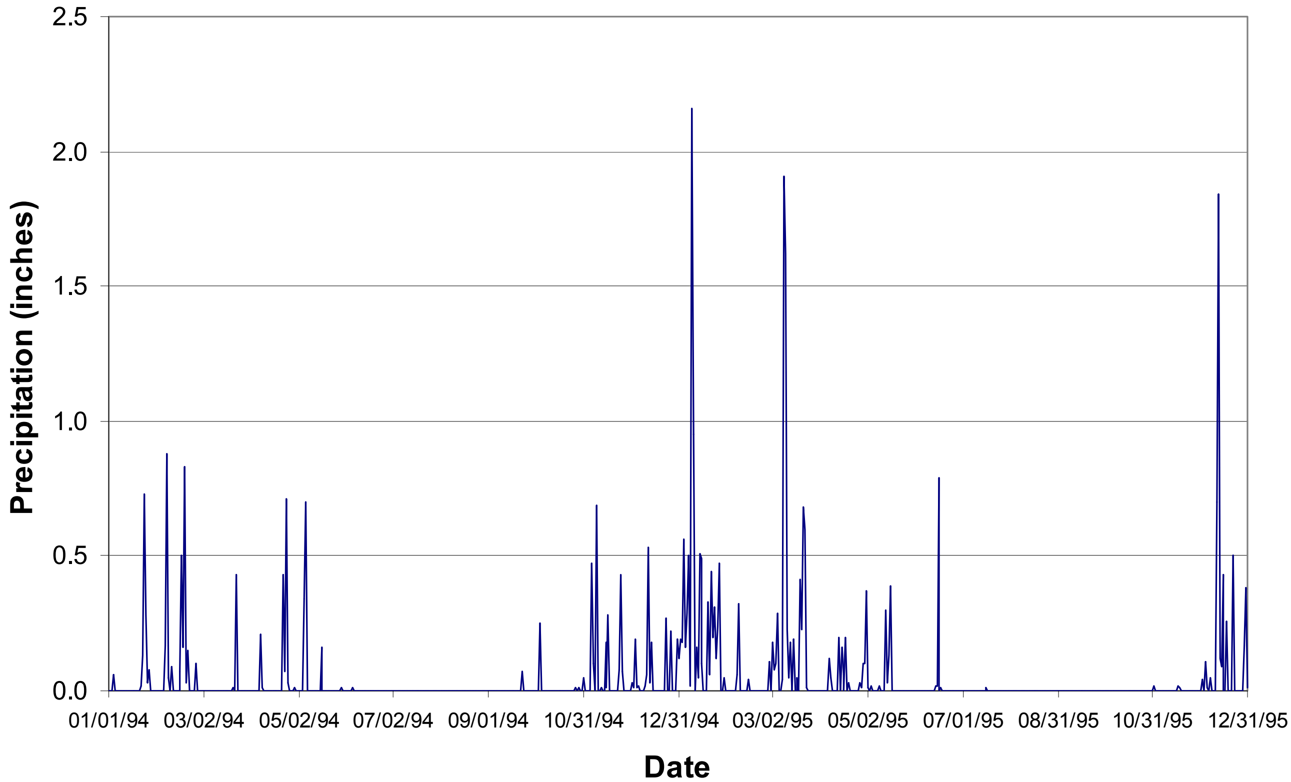


Figure 4.1.4-2 Daily Precipitation Measured in San Jose

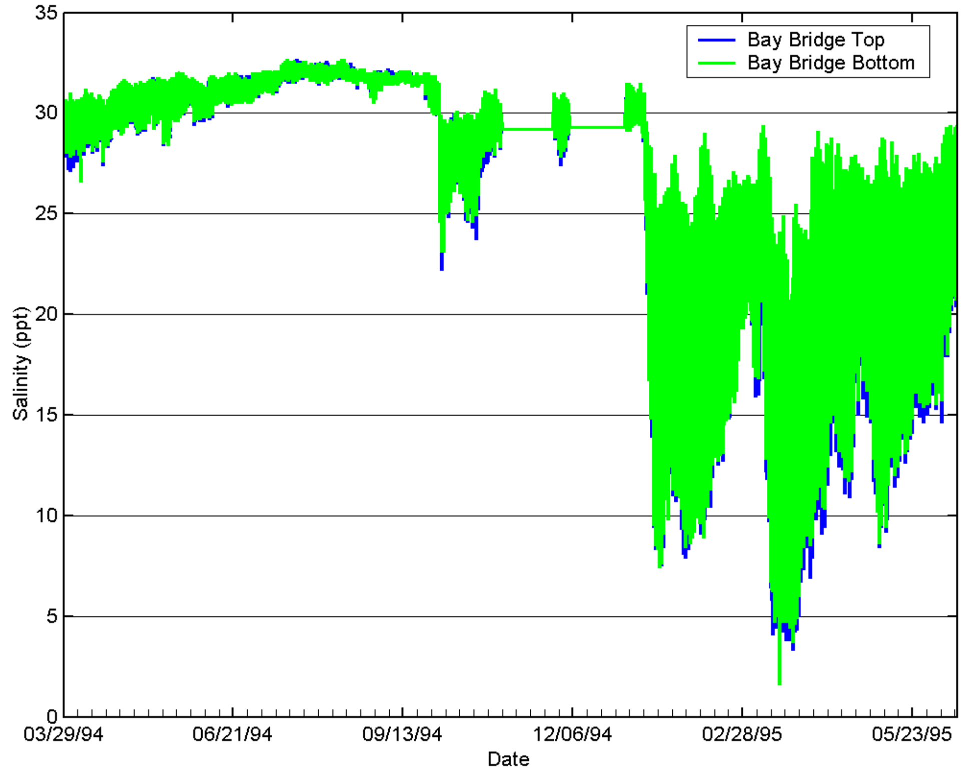


Figure 4.1.5-1 Measured Salinity at the Oakland Bay Bridge

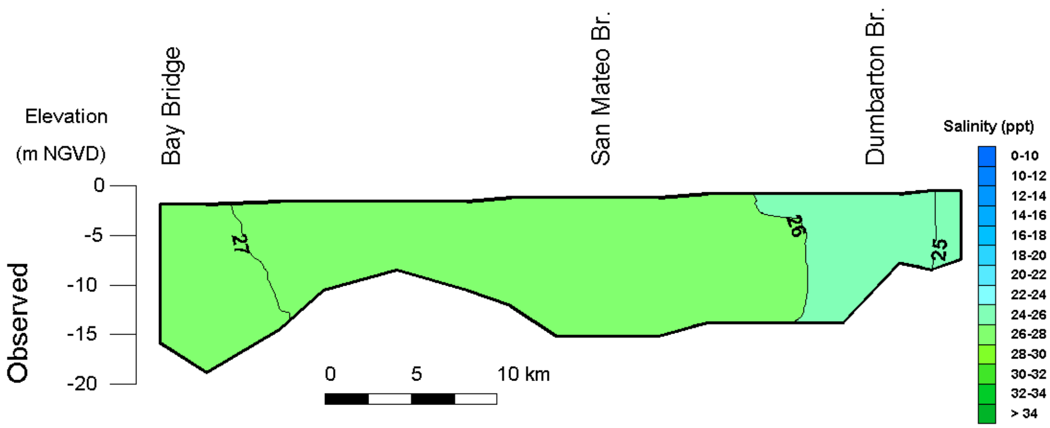


Figure 4.1.5-2 Observed Salinity on 3/29/1994

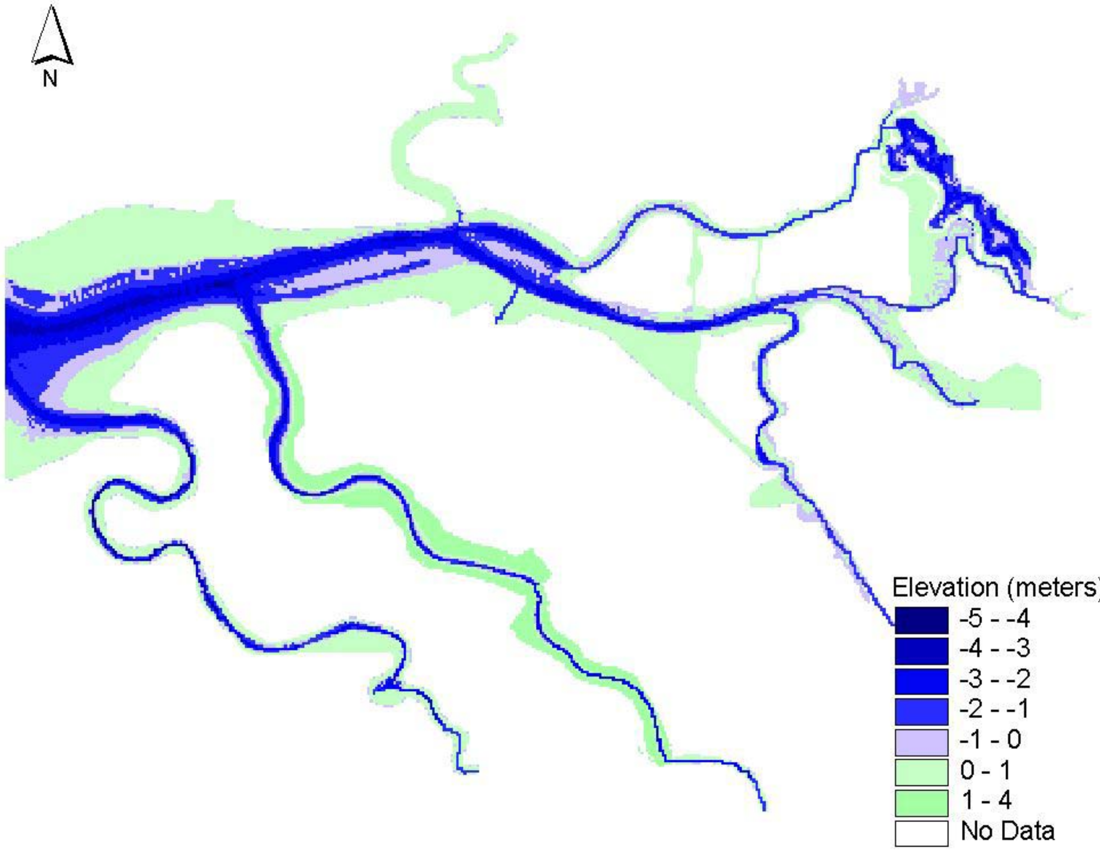


Figure 4.3-1 Alviso Region Bathymetry

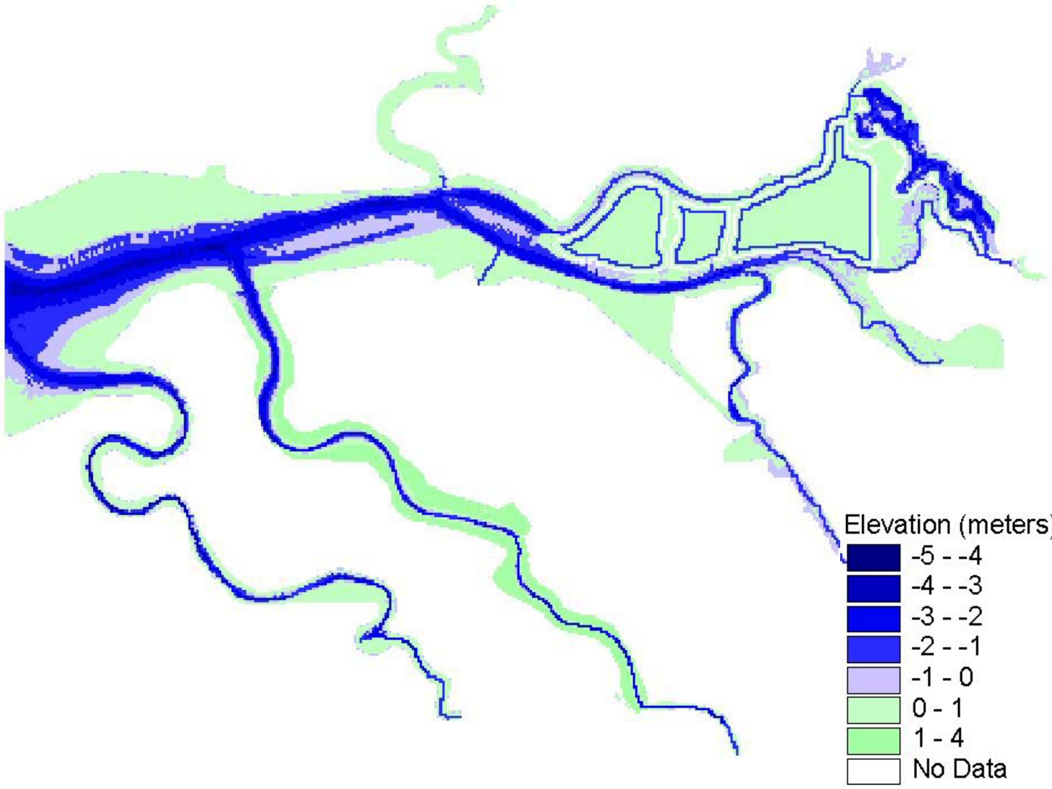
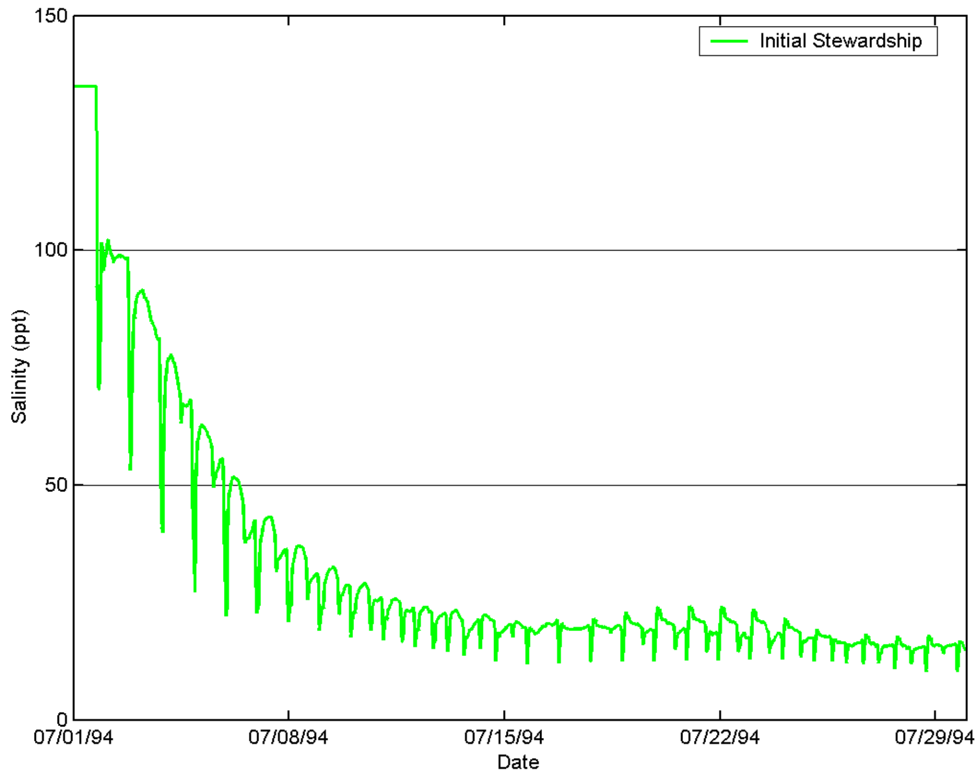
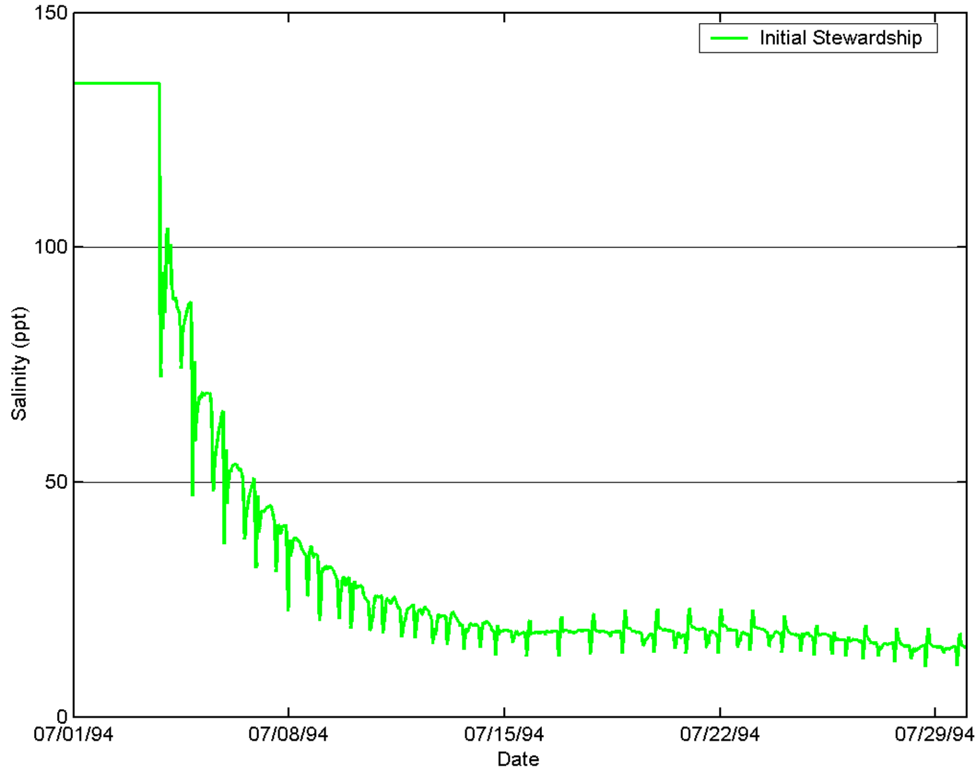


Figure 5-1 Alviso Region Bathymetry with Island Ponds and Initial Breach Geometry



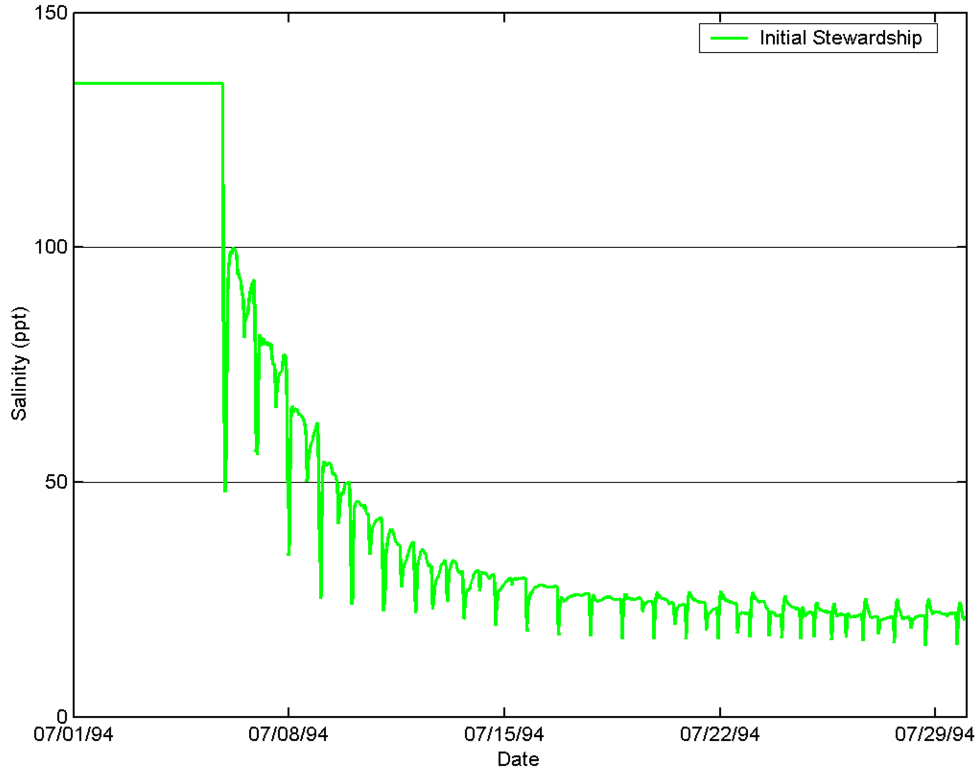
Note: Depth-averaged salinity. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.1-1 Predicted Coyote Creek Salinity at A19 Breach – Existing Conditions and Breach at Pond Bottom Elevation Scenario for July, the First Month of the Initial Breach Period



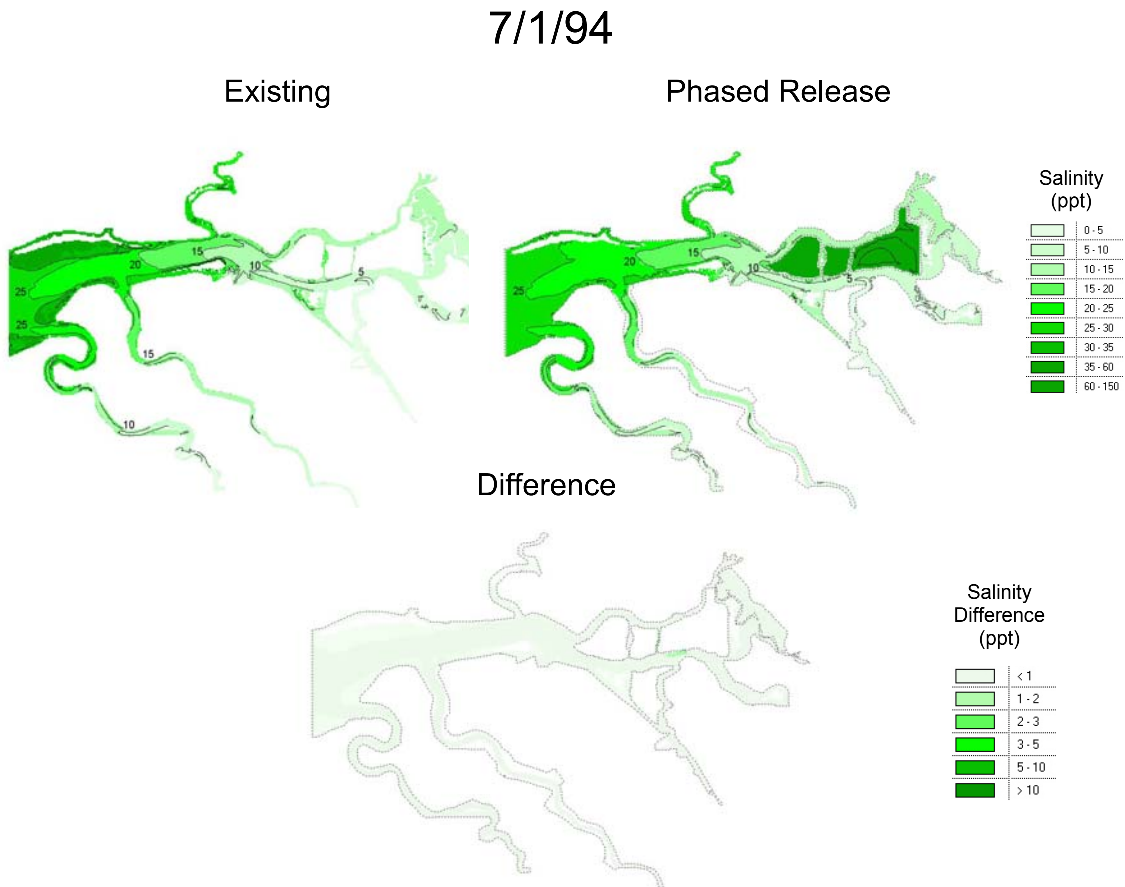
Note: Depth-averaged salinity. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.1-2 Predicted Coyote Creek Salinity at A20 Breach – Existing Conditions and Breach at Pond Bottom Elevation Scenario for July, the First Month of the Initial Breach Period



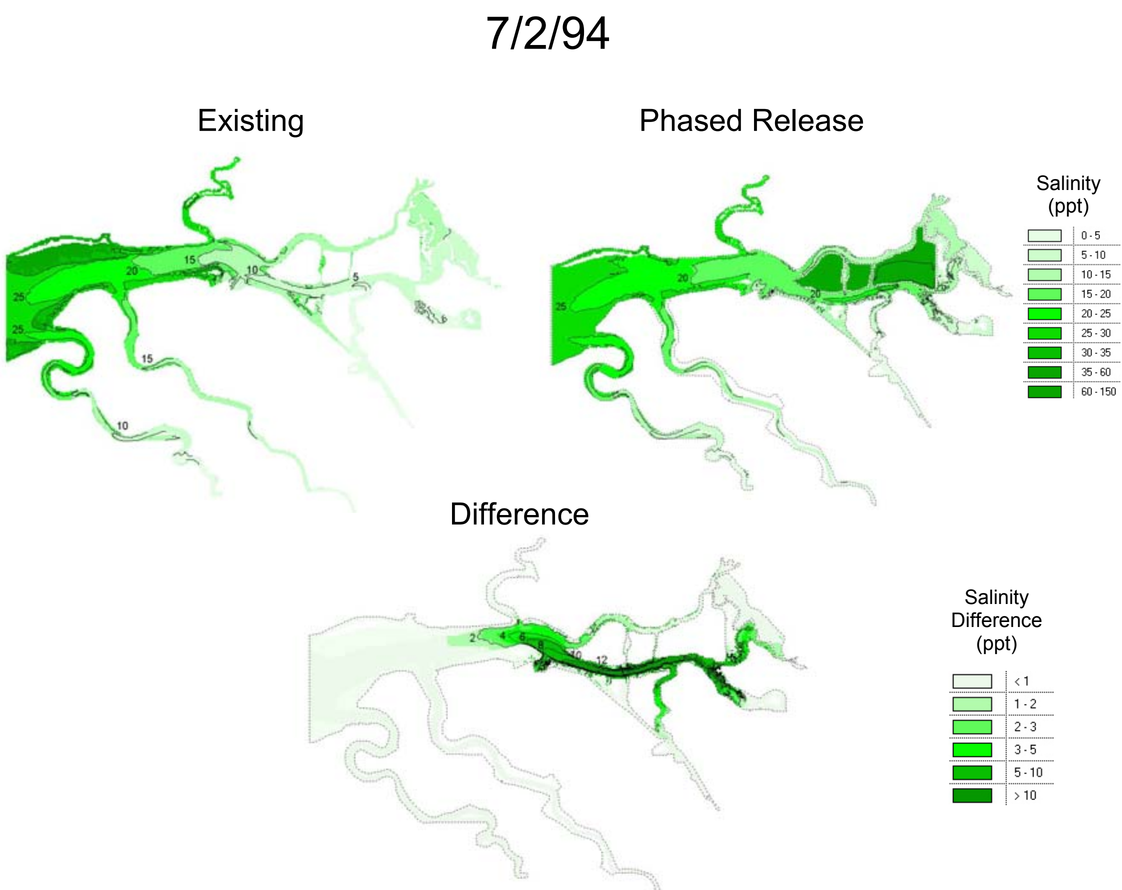
Note: Depth-averaged salinity. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.1-3 Predicted Coyote Creek Salinity at A21 Breach – Existing Conditions and Breach at Pond Bottom Elevation Scenario for July, the First Month of the Initial Breach Period



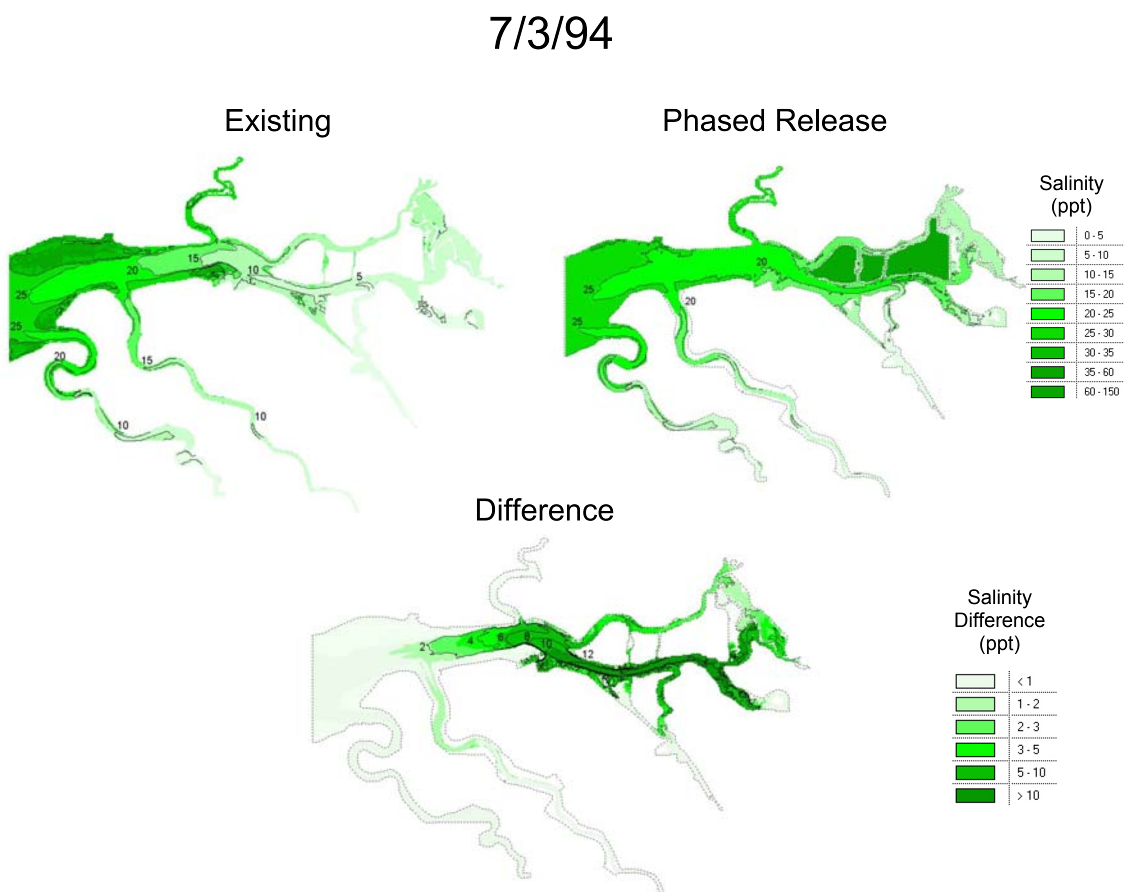
Note: Salinity map of Alviso Region indicates predicted depth-averaged and daily averaged salinity in each grid cell of the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.1-4 Predicted Alviso Region Salinity Comparison - Existing Conditions and Breach at Pond Bottom Elevation Scenario on July 1, the First Day of the Initial Breach Period



Note: Salinity map of Alviso Region indicates predicted depth-averaged and daily averaged salinity in each grid cell of the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

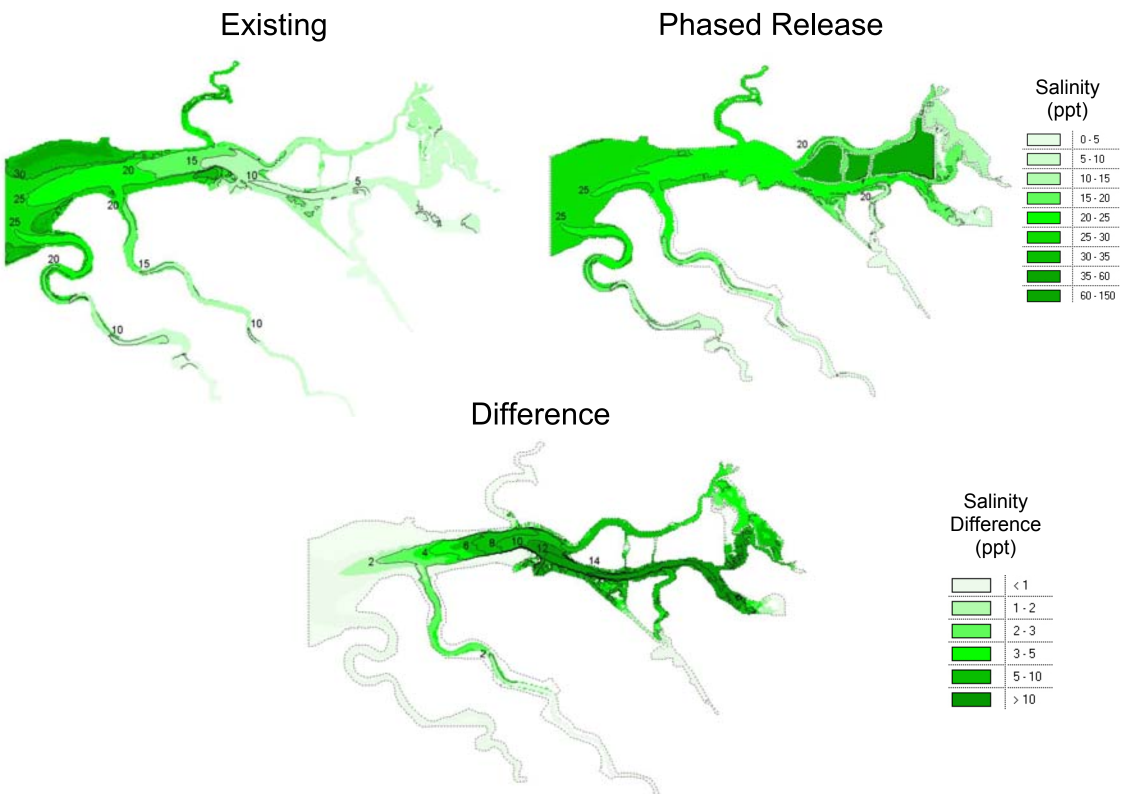
Figure 5.1-5 Predicted Alviso Region Salinity Comparison - Existing Conditions and Breach at Pond Bottom Elevation Scenario on July 2, the Second Day of the Initial Breach Period



Note: Salinity map of Alviso Region indicates predicted depth-averaged and daily averaged salinity in each grid cell of the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

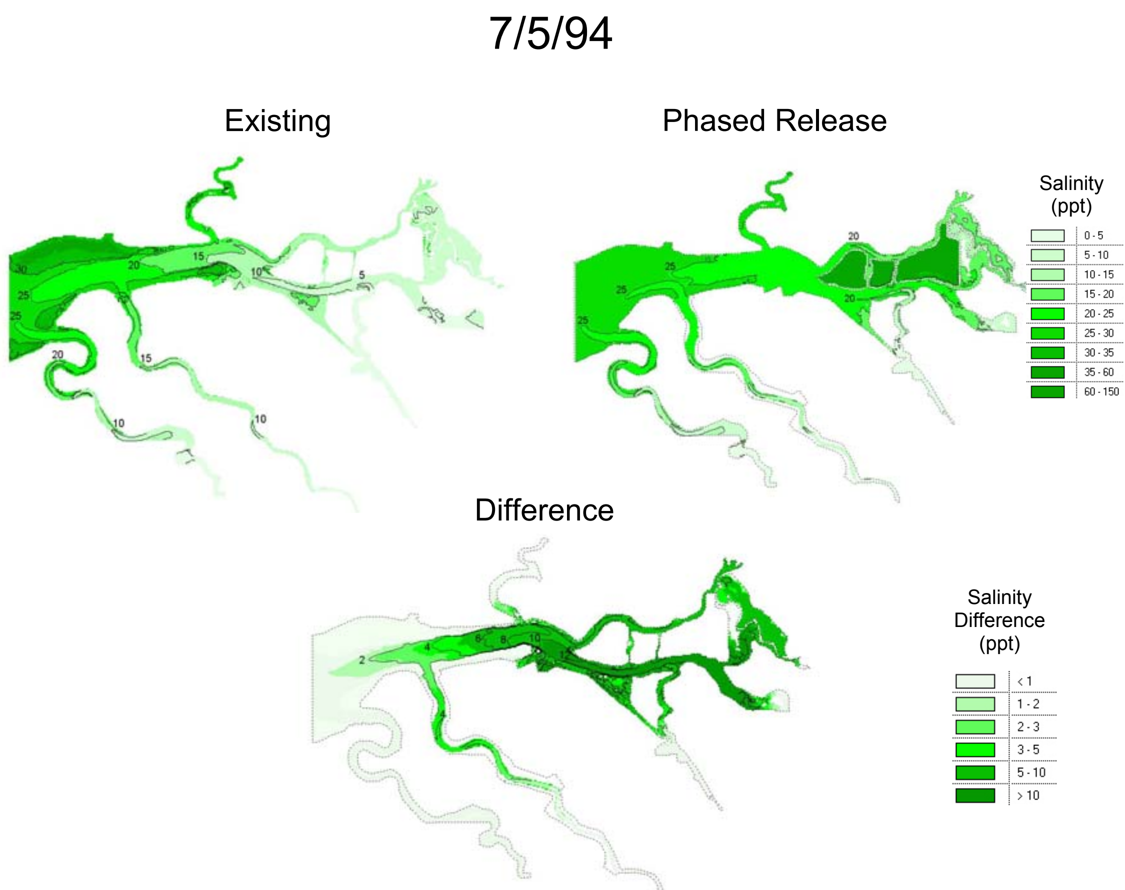
Figure 5.1-6 Predicted Alviso Region Salinity Comparison - Existing Conditions and Breach at Pond Bottom Elevation Scenario on July 3, the Third Day of the Initial Breach Period

7/4/94



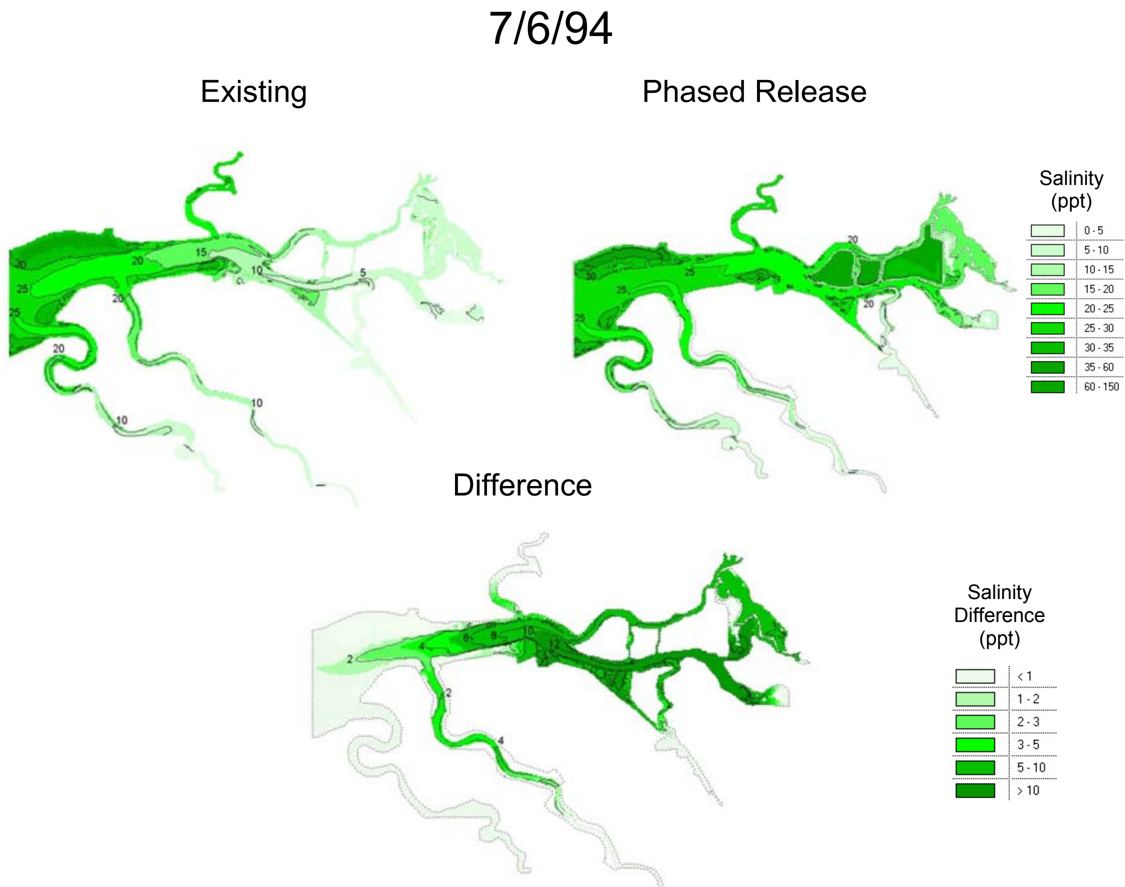
Note: Salinity map of Alviso Region indicates predicted depth-averaged and daily averaged salinity in each grid cell of the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.1-7 Predicted Alviso Region Salinity Comparison - Existing Conditions and Breach at Pond Bottom Elevation Scenario on July 4, the Fourth Day of the Initial Breach Period



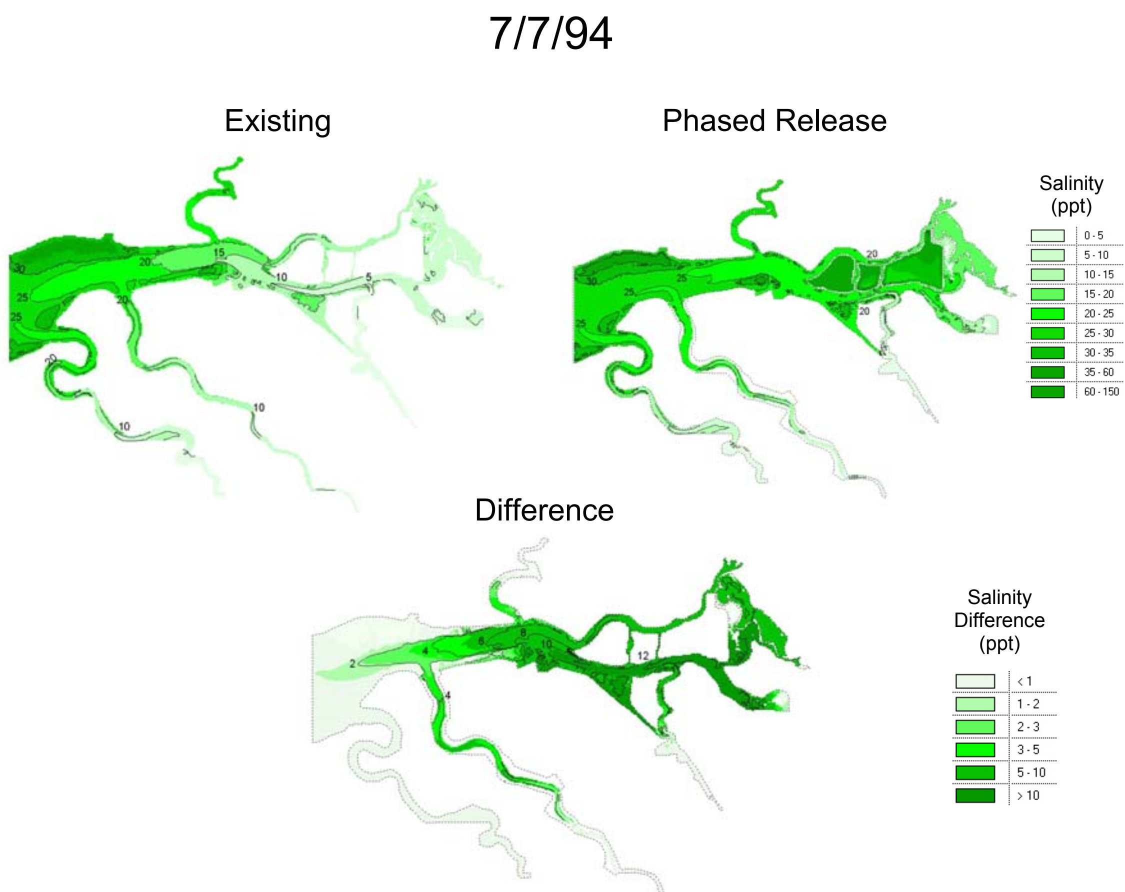
Note: Salinity map of Alviso Region indicates predicted depth-averaged and daily averaged salinity in each grid cell of the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.1-8 Predicted Alviso Region Salinity Comparison - Existing Conditions and Breach at Pond Bottom Elevation Scenario on July 5, the Fifth Day of the Initial Breach Period



Note: Salinity map of Alviso Region indicates predicted depth-averaged and daily averaged salinity in each grid cell of the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

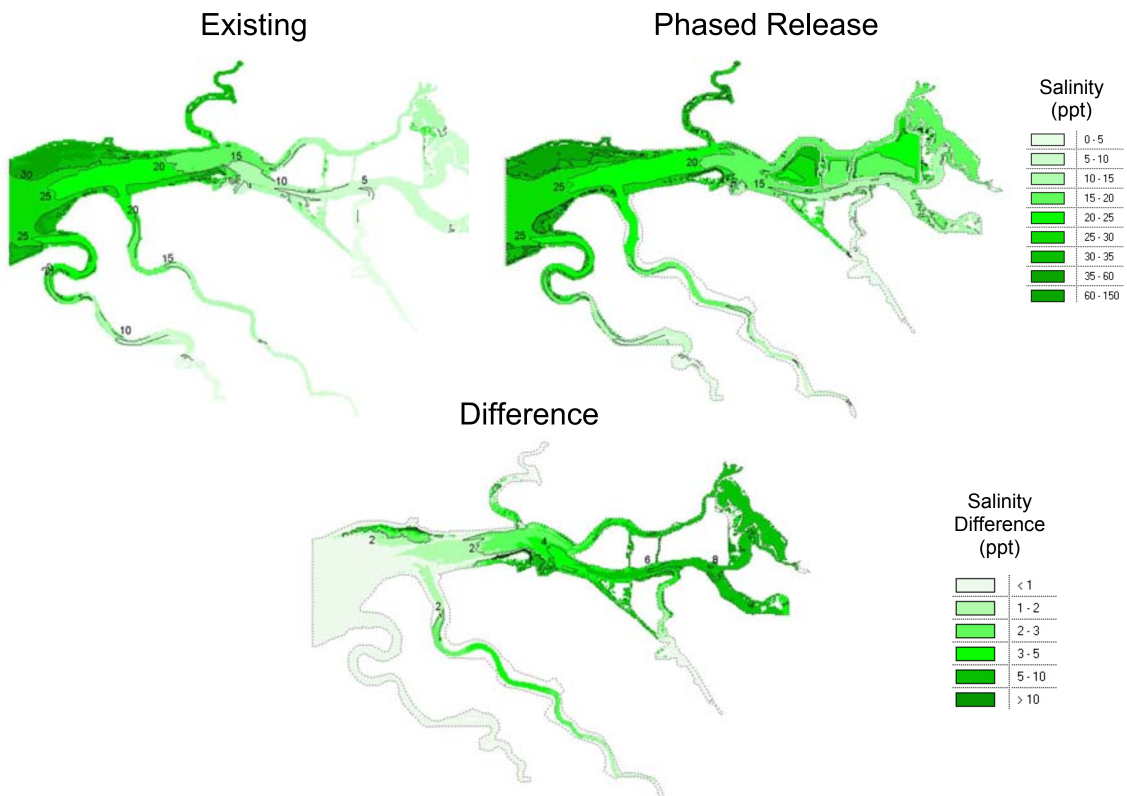
Figure 5.1-9 Predicted Alviso Region Salinity Comparison - Existing Conditions and Breach at Pond Bottom Elevation Scenario on July 6, the Sixth Day of the Initial Breach Period



Note: Salinity map of Alviso Region indicates predicted depth-averaged and daily averaged salinity in each grid cell of the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

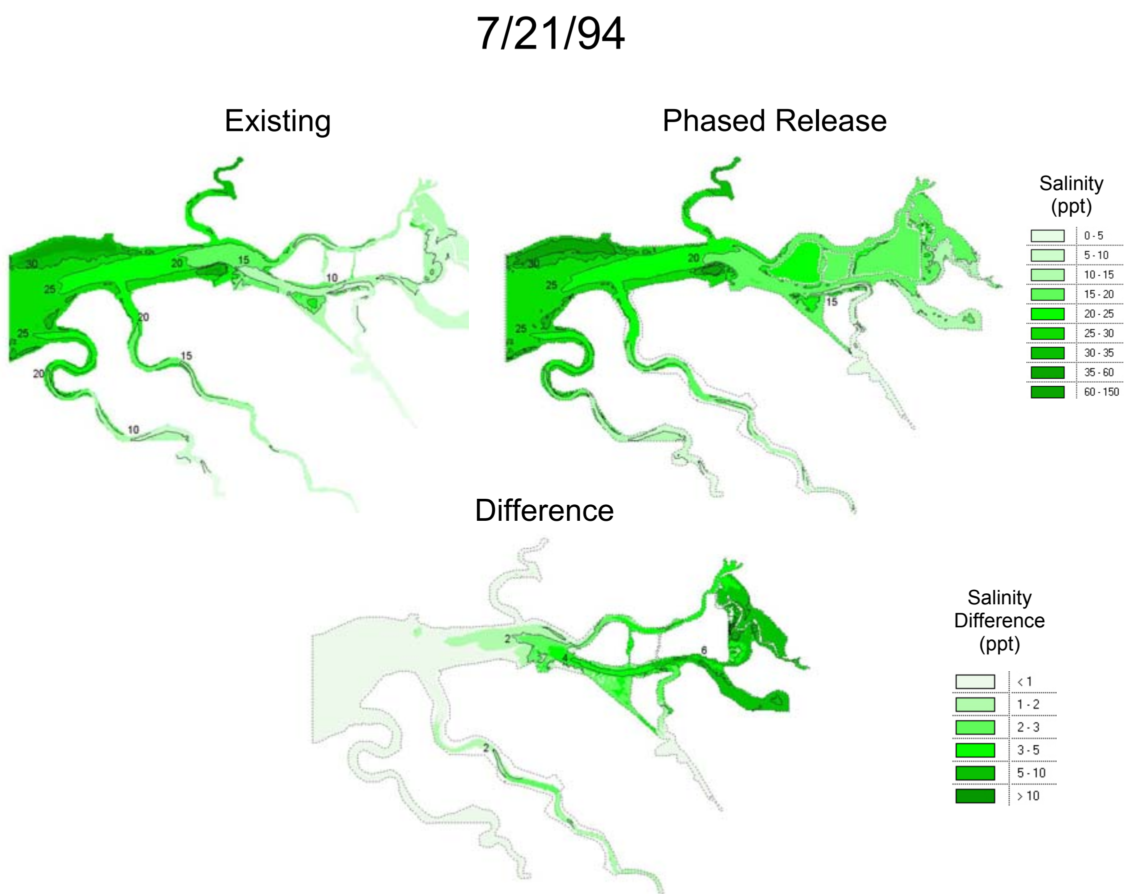
Figure 5.1-10 Predicted Alviso Region Salinity Comparison - Existing Conditions and Breach at Pond Bottom Elevation Scenario on July 7, One Week into the Initial Breach Period

7/14/94



Note: Salinity map of Alviso Region indicates predicted depth-averaged and daily averaged salinity in each grid cell of the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

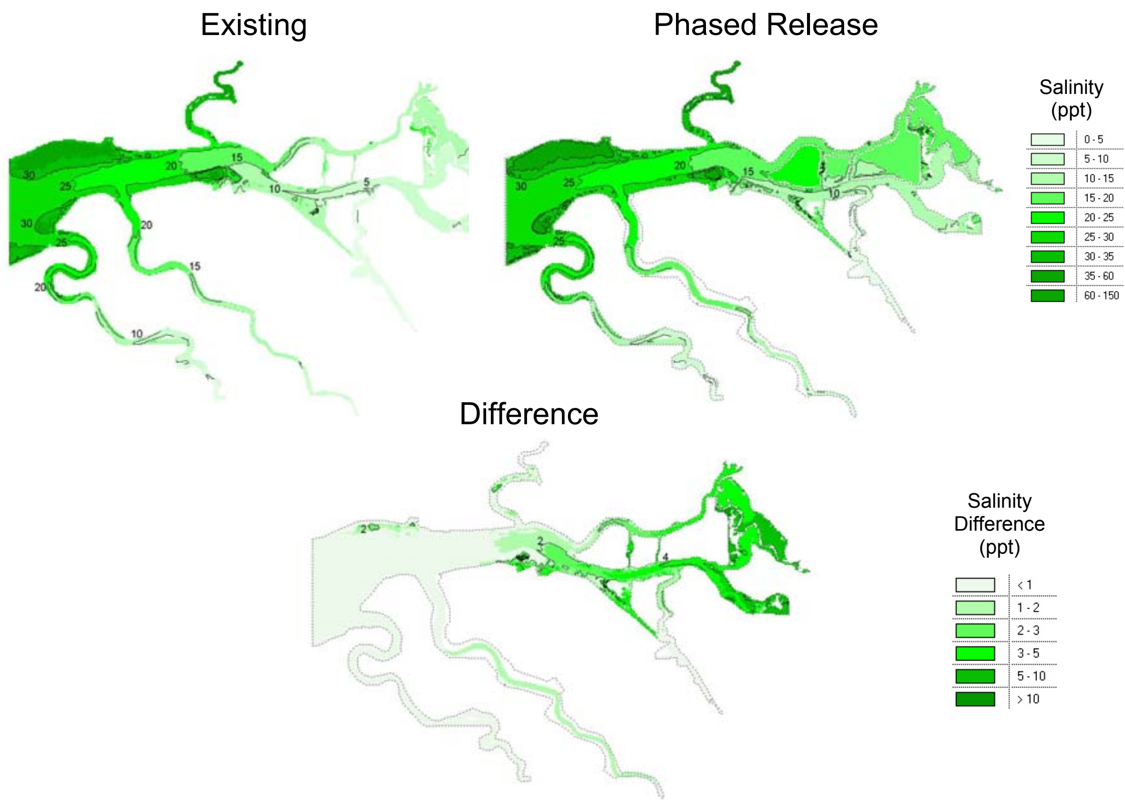
Figure 5.1-11 Predicted Alviso Region Salinity Comparison - Existing Conditions and Breach at Pond Bottom Elevation Scenario on July 14, Two Weeks into the Initial Breach Period



Note: Salinity map of Alviso Region indicates predicted depth-averaged and daily averaged salinity in each grid cell of the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.1-12 Predicted Alviso Region Salinity Comparison - Existing Conditions and Breach at Pond Bottom Elevation Scenario on July 21, Three Weeks into the Initial Breach Period

7/28/94



Note: Salinity map of Alviso Region indicates predicted depth-averaged and daily averaged salinity in each grid cell of the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.1-13 Predicted Alviso Region Salinity Comparison - Existing Conditions and Breach at Pond Bottom Elevation Scenario on July 28, Four Weeks into the Initial Breach Period

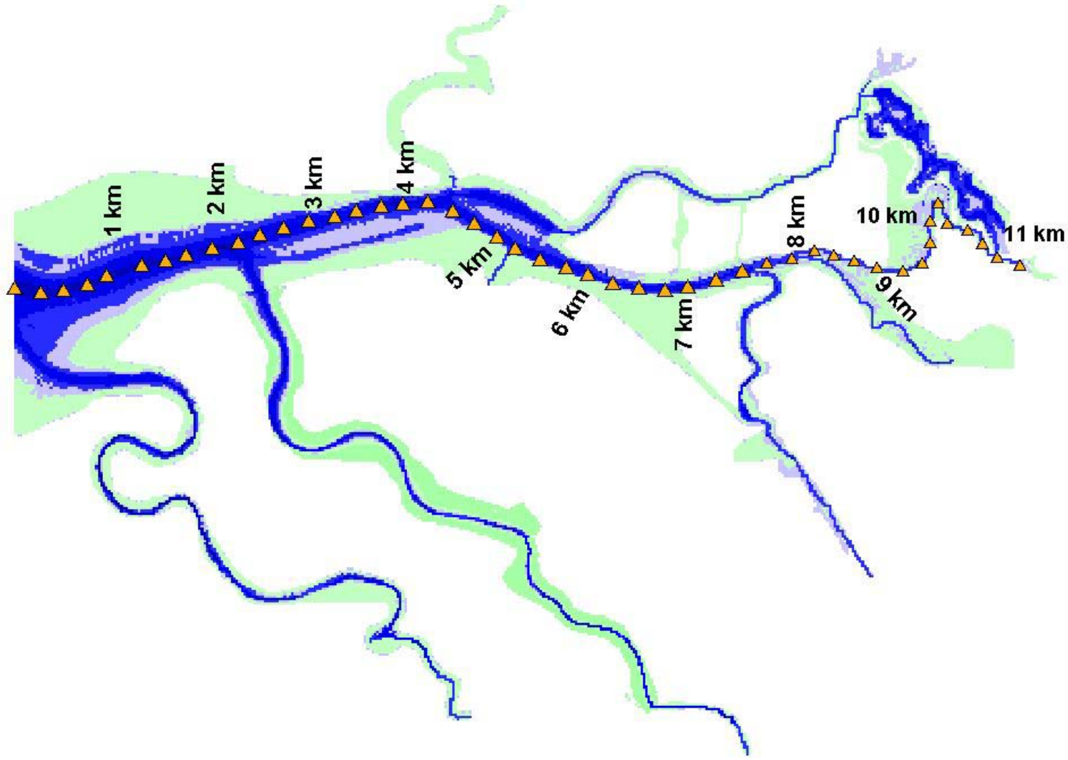
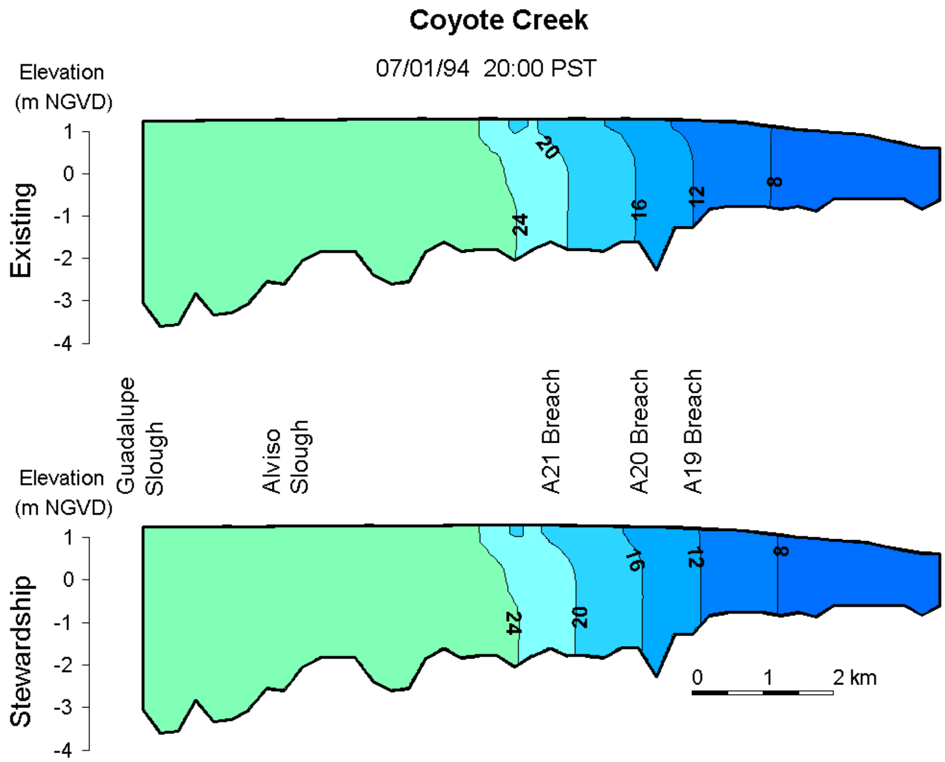
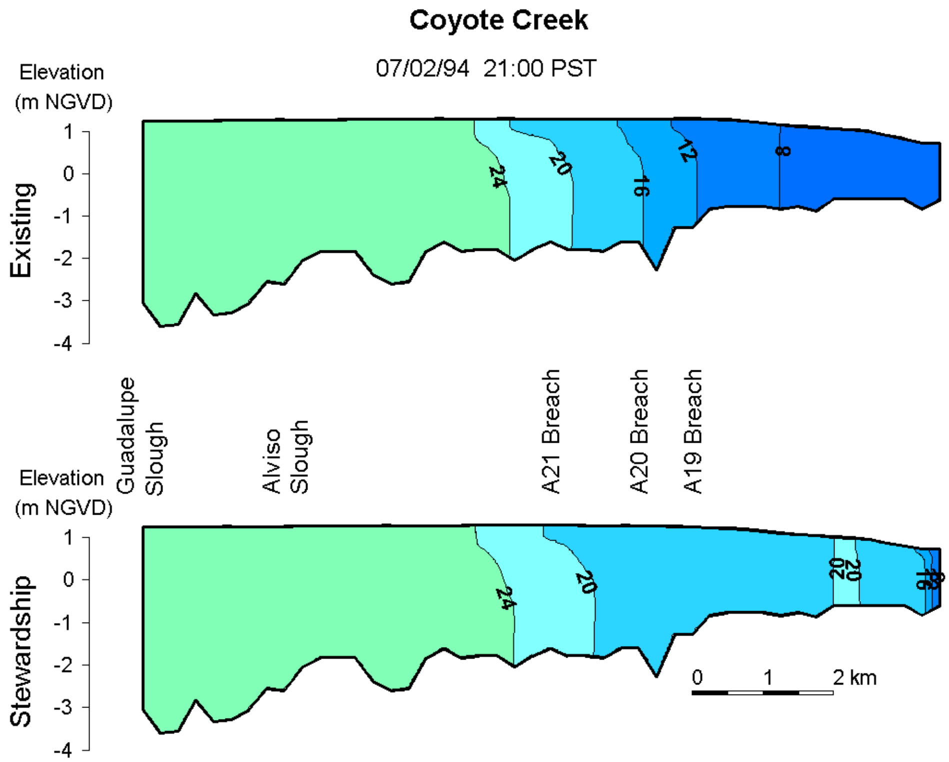


Figure 5.1-14 Longitudinal Transect Stations along the Centerline of Coyote Creek at 250 meter Increments



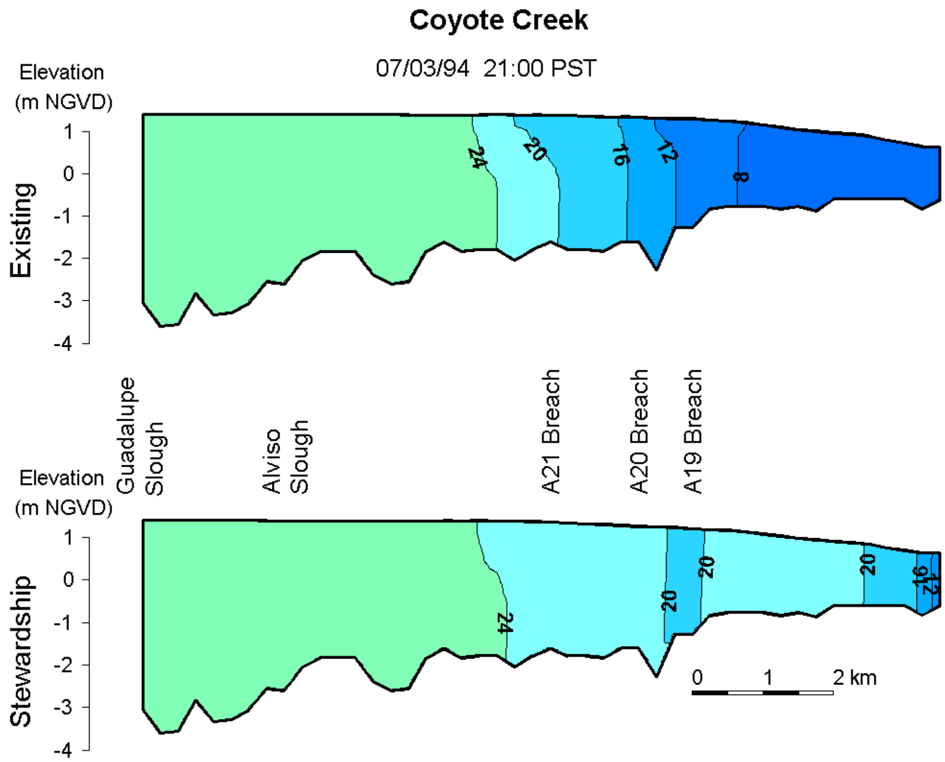
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.1-15 Predicted Coyote Creek Salinity Comparison - Existing Conditions and Breach at Pond Bottom Elevation Scenario on July 1, the First Day of the Initial Breach Period



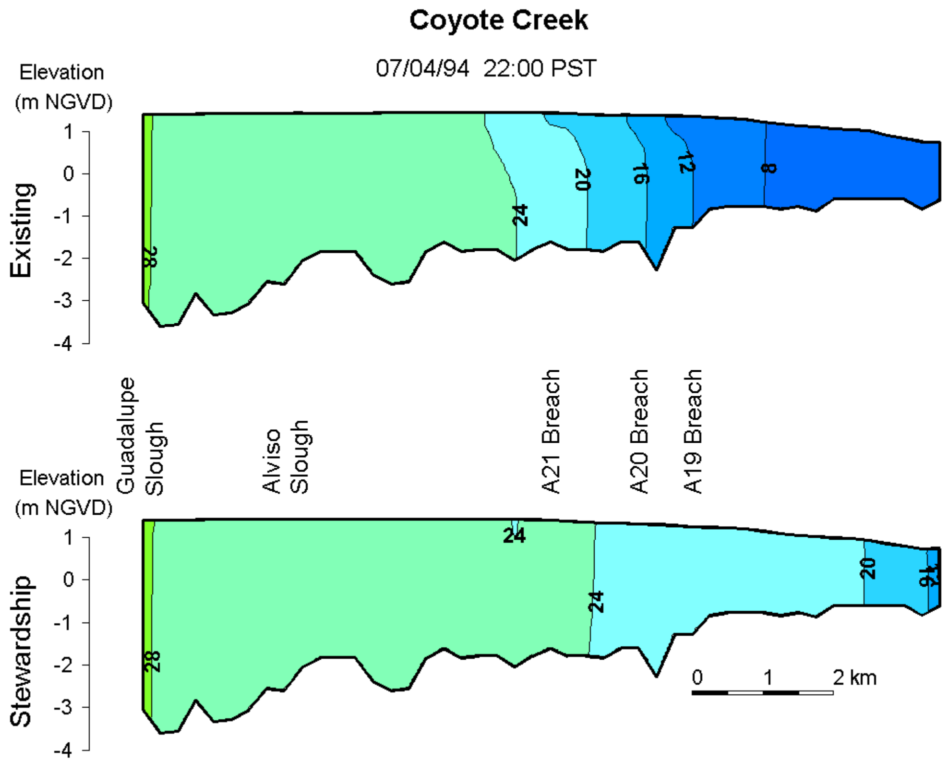
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.1-16 Predicted Coyote Creek Salinity Comparison - Existing Conditions and Breach at Pond Bottom Elevation Scenario on July 2, the Second Day of the Initial Breach Period



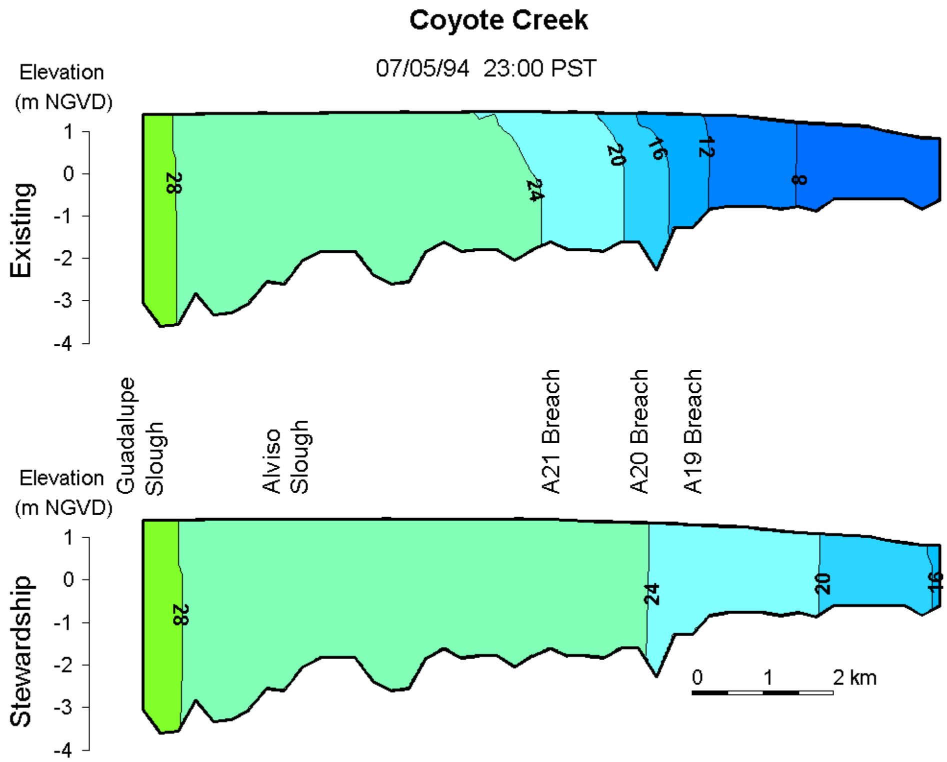
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.1-17 Predicted Coyote Creek Salinity Comparison - Existing Conditions and Breach at Pond Bottom Elevation Scenario on July 3, the Third Day of the Initial Breach Period



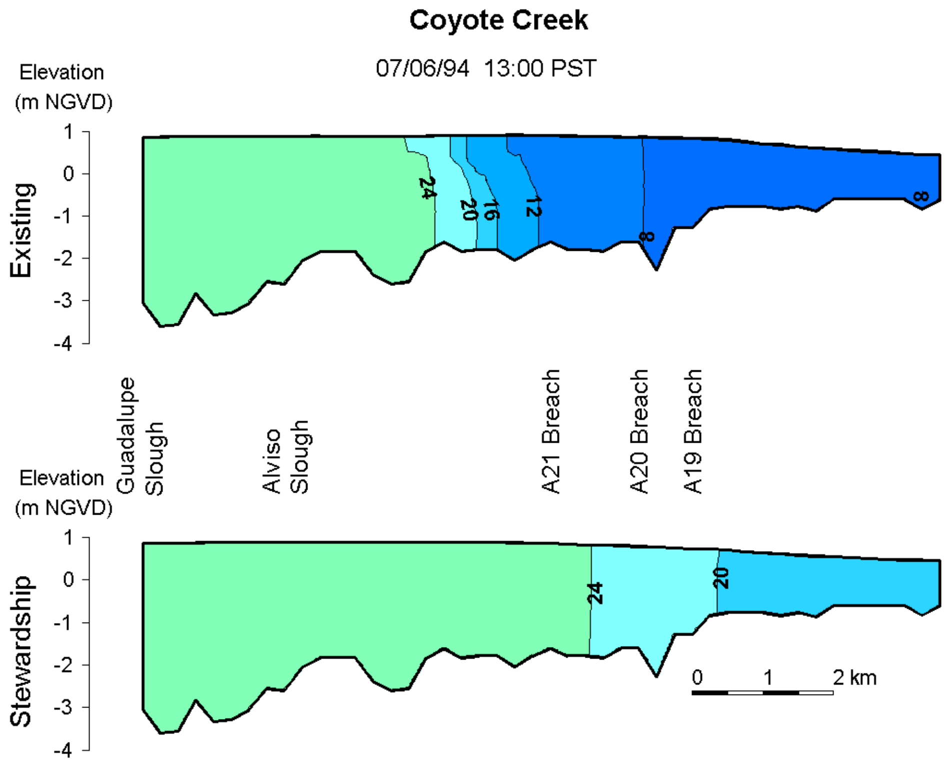
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.1-18 Predicted Coyote Creek Salinity Comparison - Existing Conditions and Breach at Pond Bottom Elevation Scenario on July 4, the Fourth Day of the Initial Breach Period



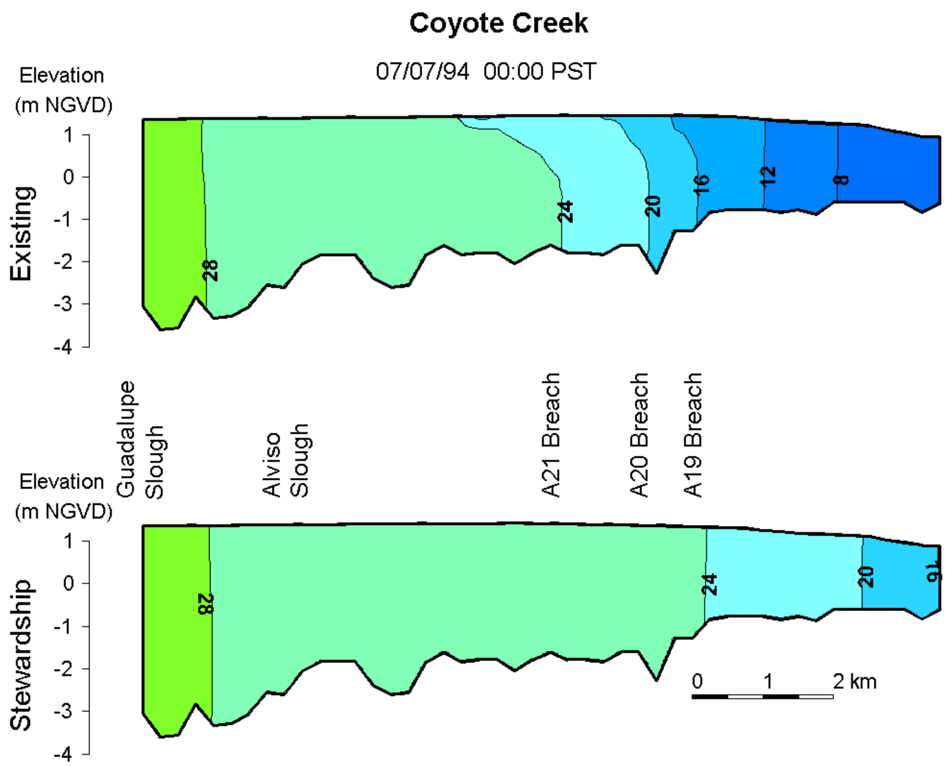
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.1-19 Predicted Coyote Creek Salinity Comparison - Existing Conditions and Breach at Pond Bottom Elevation Scenario on July 5, the Fifth Day of the Initial Breach Period



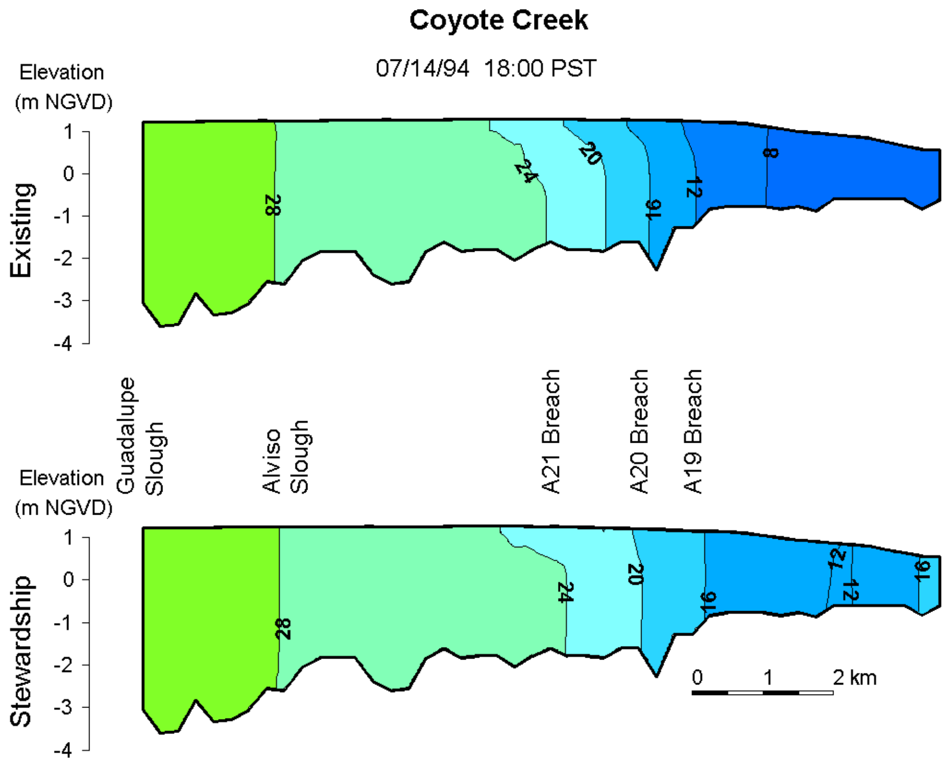
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.1-20 Predicted Coyote Creek Salinity Comparison - Existing Conditions and Breach at Pond Bottom Elevation Scenario on July 6, the Sixth Day of the Initial Breach Period



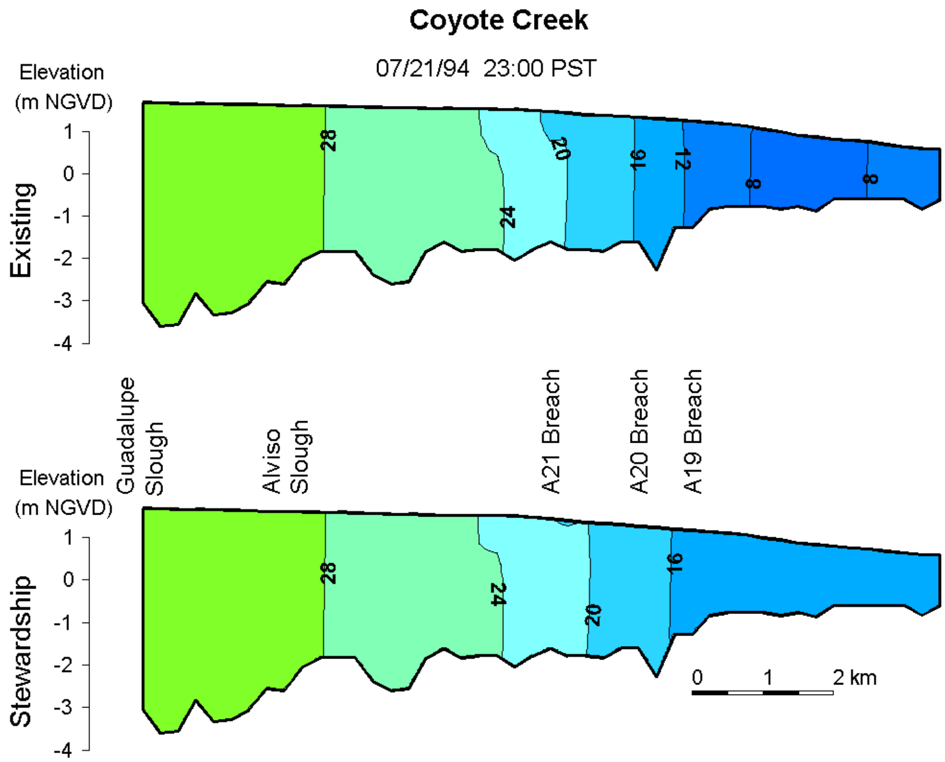
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.1-21 Predicted Coyote Creek Salinity Comparison - Existing Conditions and Breach at Pond Bottom Elevation Scenario on July 7, One Week into the Initial Breach Period



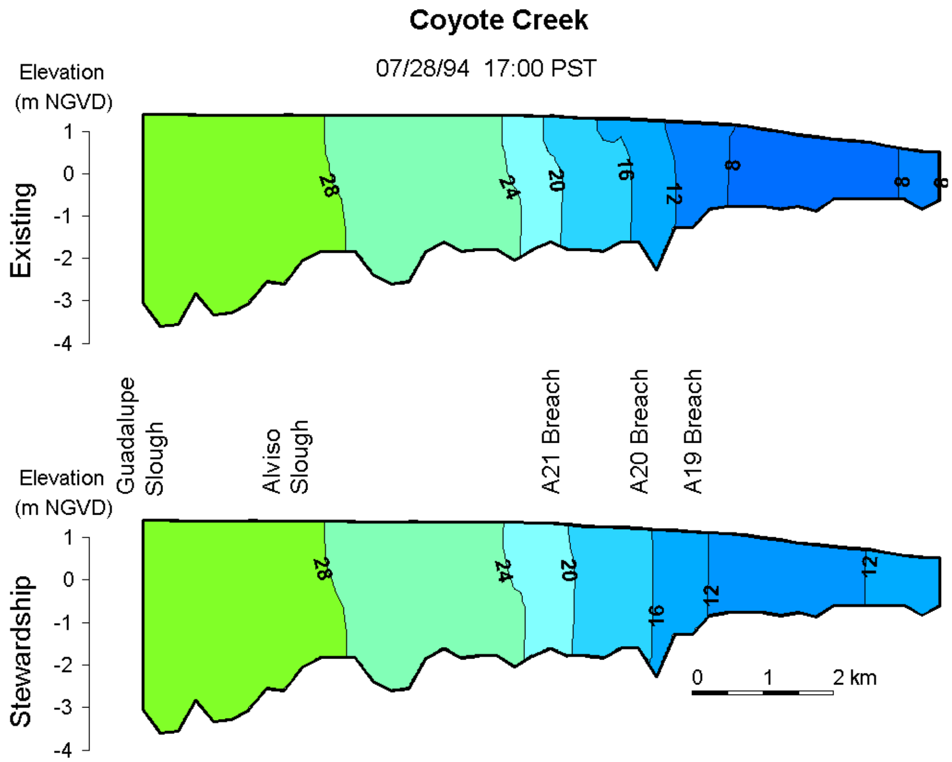
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.1-22 Predicted Coyote Creek Salinity Comparison - Existing Conditions and Breach at Pond Bottom Elevation Scenario on July 14, Two Weeks into the Initial Breach Period



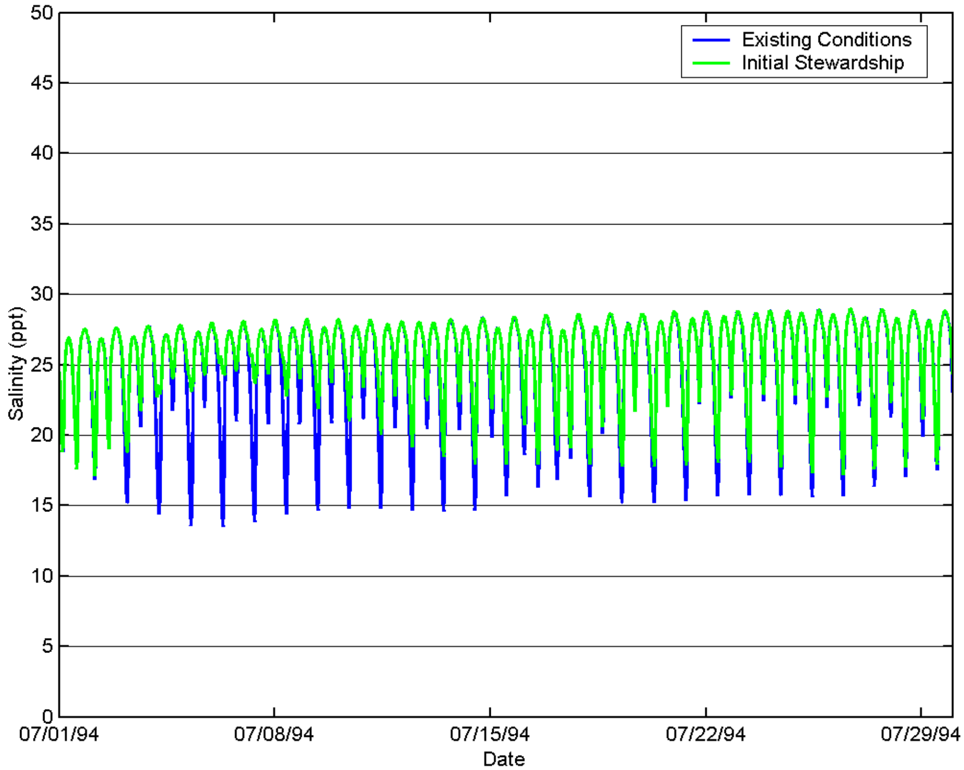
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.1-23 Predicted Coyote Creek Salinity Comparison - Existing Conditions and Breach at Pond Bottom Elevation Scenario on July 21, Three Weeks into the Initial Breach Period



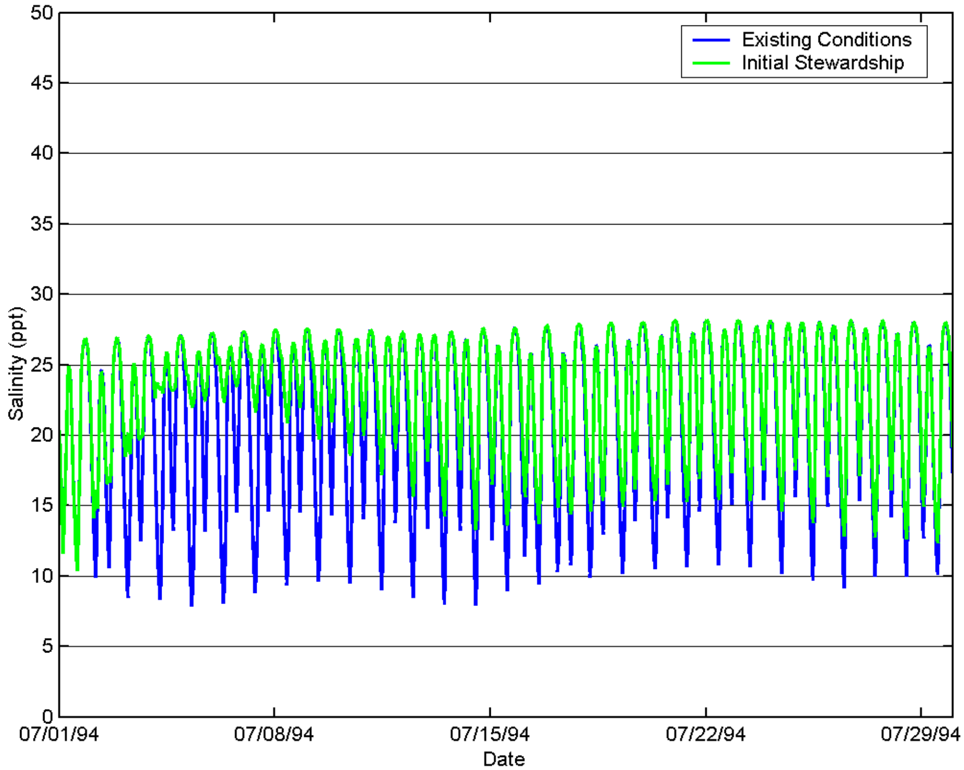
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.1-24 Predicted Coyote Creek Salinity Comparison - Existing Conditions and Breach at Pond Bottom Elevation Scenario on July 28, Four Weeks into the Initial Breach Period



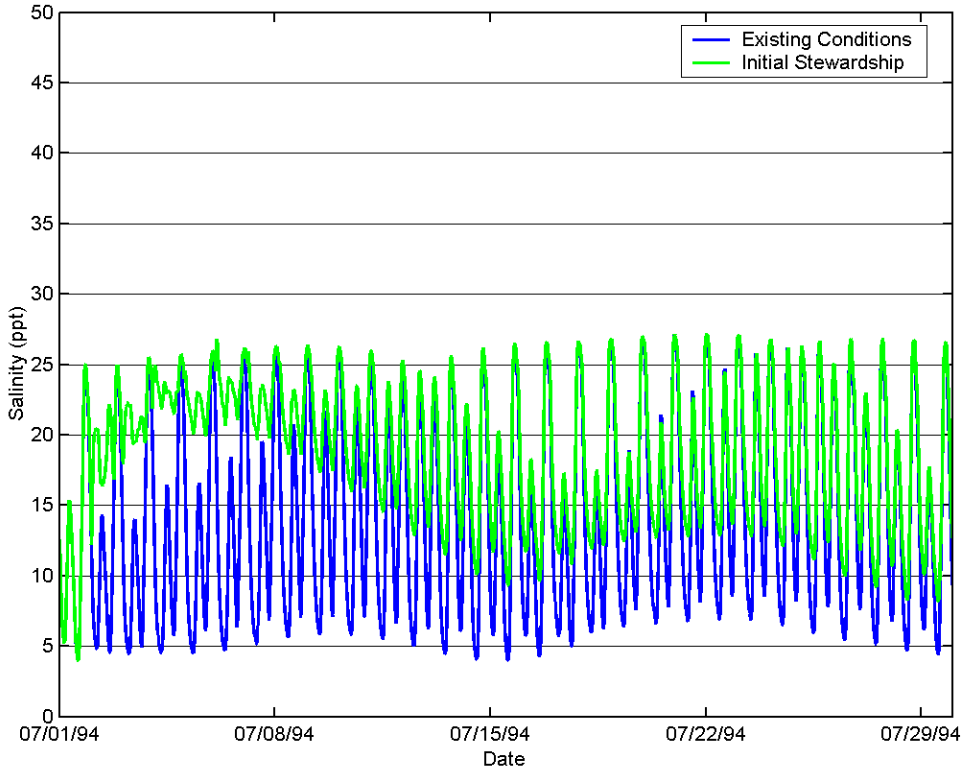
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.1-25 Predicted Coyote Creek 1 km Station Salinity – Existing Conditions and Breach at Pond Bottom Elevation Scenario for July, the First Month of the Initial Breach Period



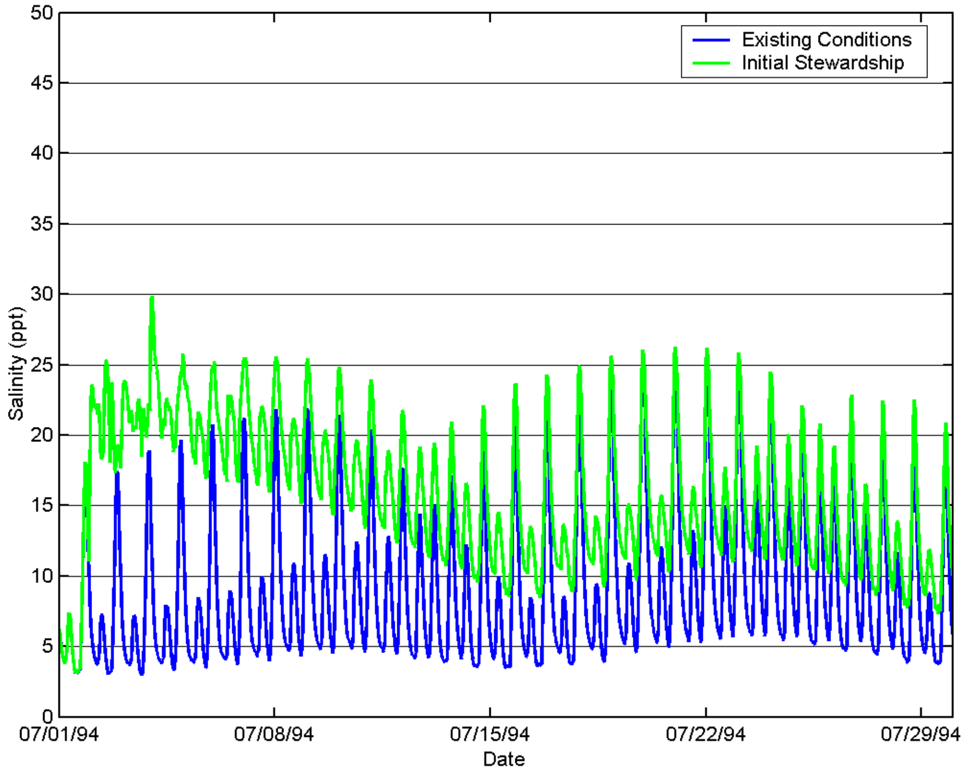
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.1-26 Predicted Coyote Creek 3 km Station Salinity – Existing Conditions and Breach at Pond Bottom Elevation Scenario for July, the First Month of the Initial Breach Period



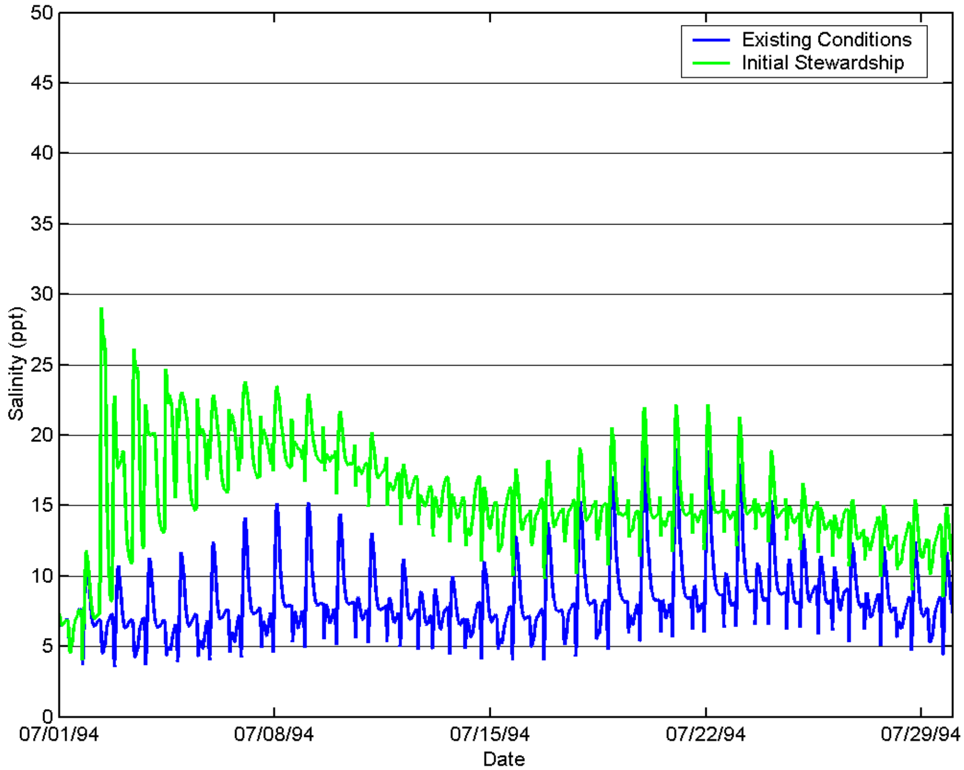
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.1-27 Predicted Coyote Creek 5 km Station Salinity – Existing Conditions and Breach at Pond Bottom Elevation Scenario for July, the First Month of the Initial Breach Period



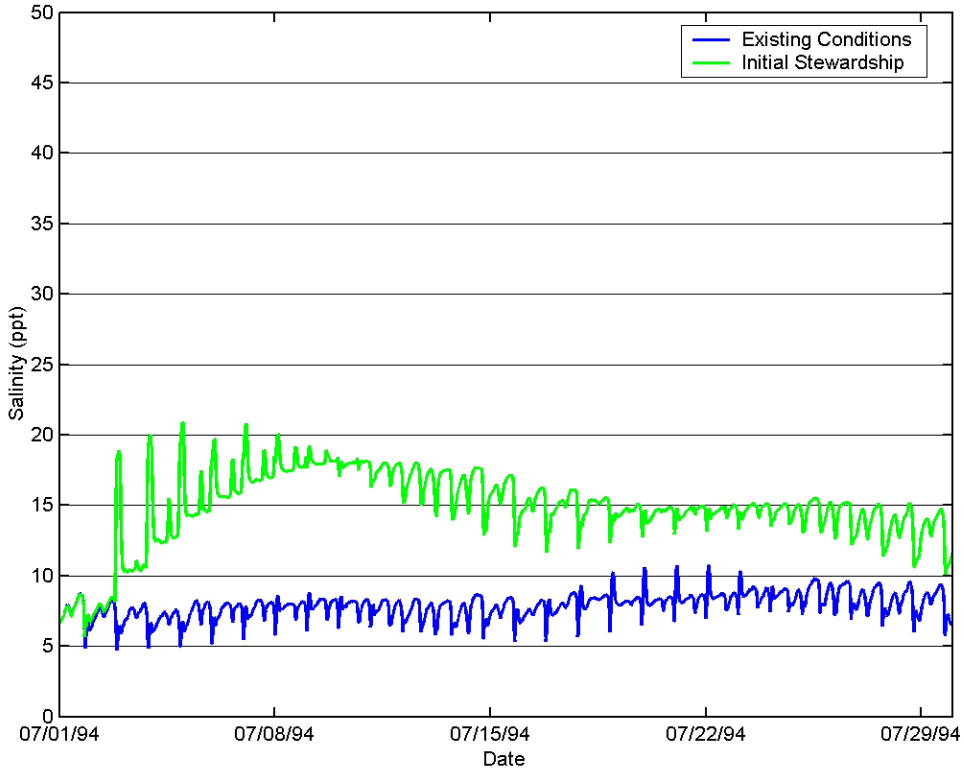
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.1-28 Predicted Coyote Creek 7 km Station Salinity – Existing Conditions and Breach at Pond Bottom Elevation Scenario for July, the First Month of the Initial Breach Period



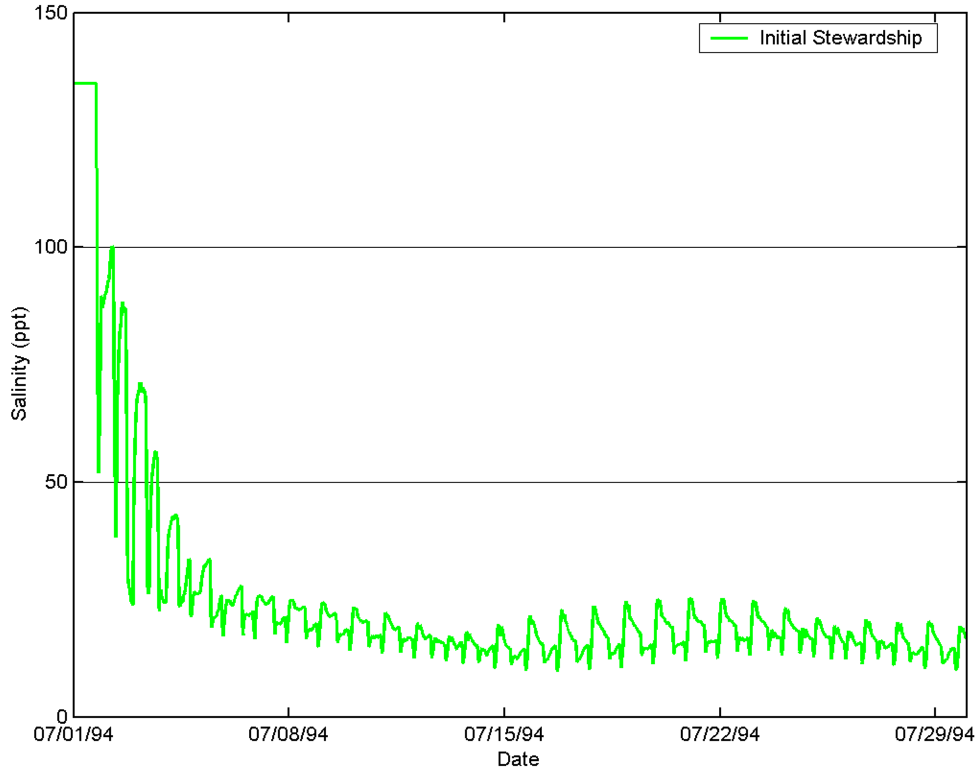
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.1-29 Predicted Coyote Creek 9 km Station Salinity – Existing Conditions and Breach at Pond Bottom Elevation Scenario for July, the First Month of the Initial Breach Period



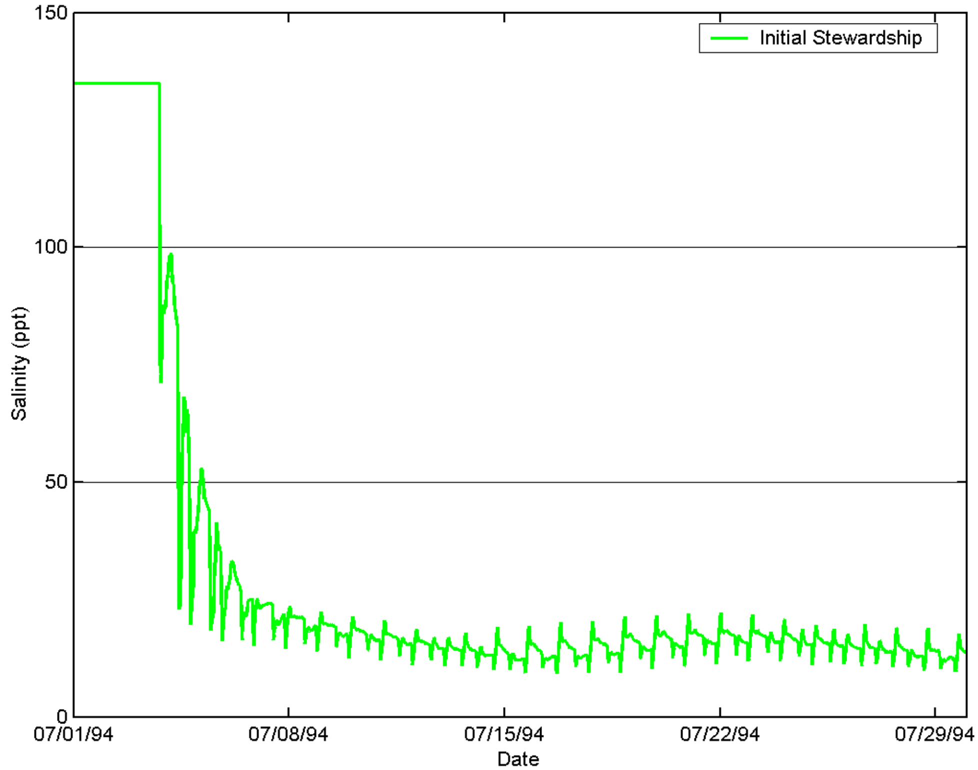
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.1-30 Predicted Coyote Creek 11 km Station Salinity – Existing Conditions and Breach at Pond Bottom Elevation Scenario for July, the First Month of the Initial Breach Period



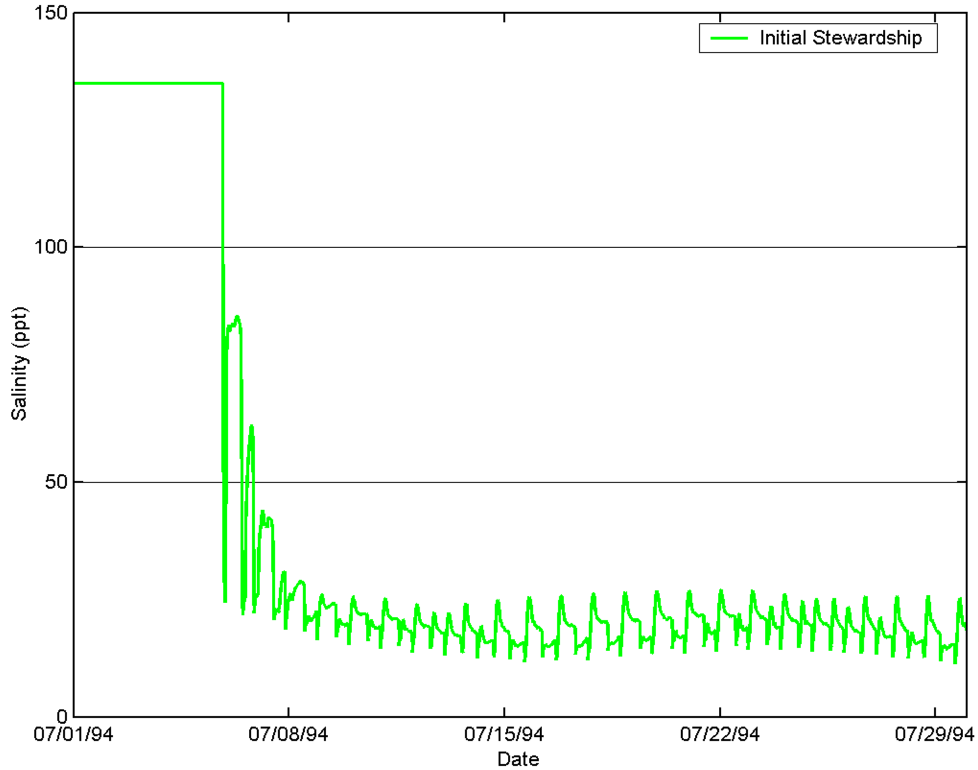
Note: Depth-averaged salinity. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.2-1 Predicted Coyote Creek Salinity at A19 Breach – Existing Conditions and Breach at 0 ft NGVD Scenario for July, the First Month of the Initial Breach Period



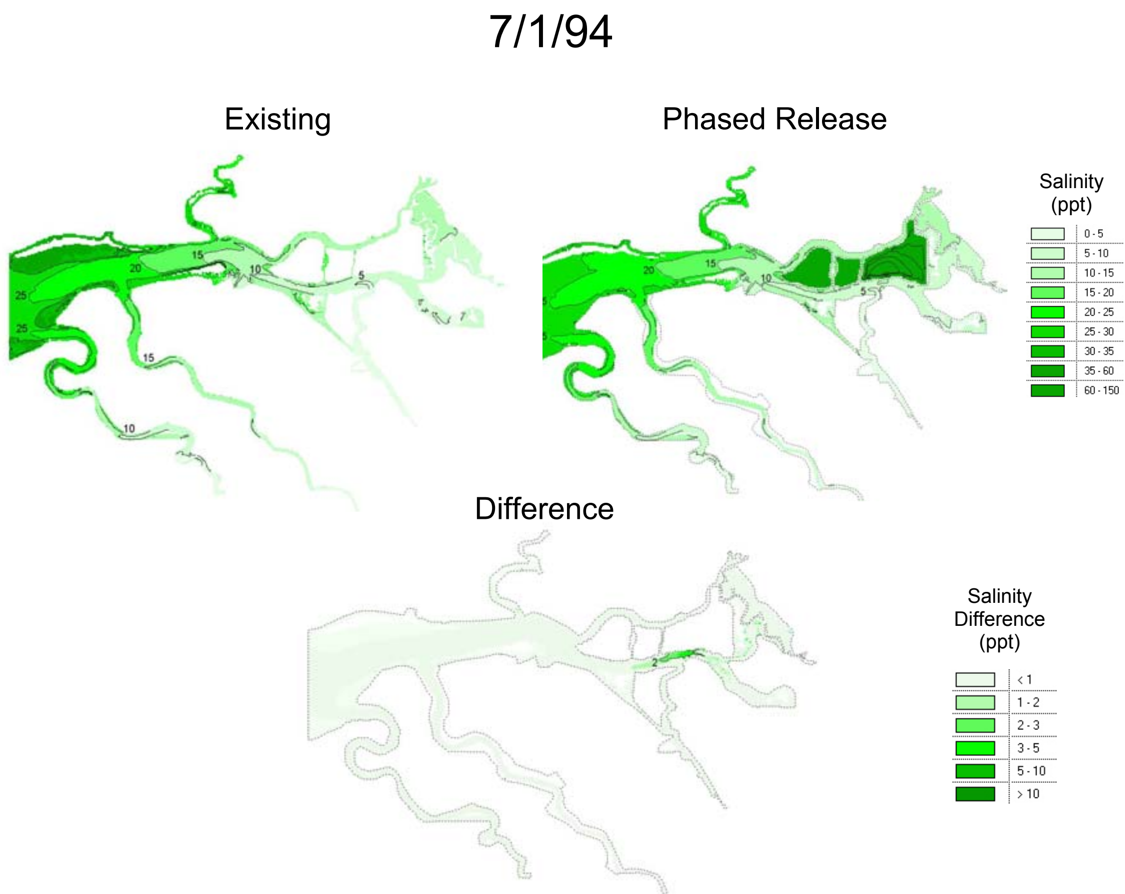
Note: Depth-averaged salinity. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.2-2 Predicted Coyote Creek Salinity at A20 Breach – Existing Conditions and Breach at 0 ft NGVD Scenario for July, the First Month of the Initial Breach Period



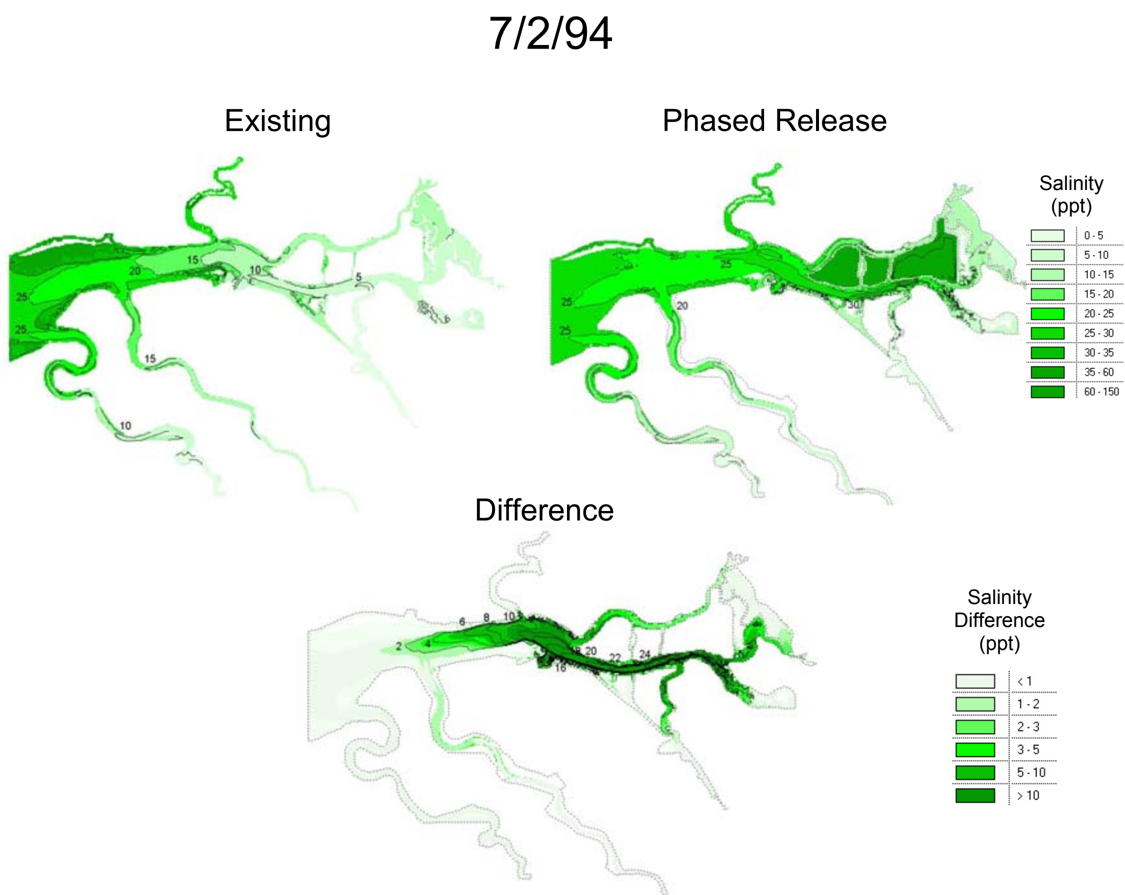
Note: Depth-averaged salinity. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.2-3 Predicted Coyote Creek Salinity at A21 Breach – Existing Conditions and Breach at 0 ft NGVD Scenario for July, the First Month of the Initial Breach Period



Note: Salinity map of Alviso Region indicates predicted depth-averaged and daily averaged salinity in each grid cell of the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.2-4 Predicted Alviso Region Salinity Comparison - Existing Conditions and Breach at 0 ft NGVD Scenario on July 1, the First Day of the Initial Breach Period



Note: Salinity map of Alviso Region indicates predicted depth-averaged and daily averaged salinity in each grid cell of the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.2-5 Predicted Alviso Region Salinity Comparison - Existing Conditions and Breach at 0 ft NGVD Scenario on July 2, the Second Day of the Initial Breach Period

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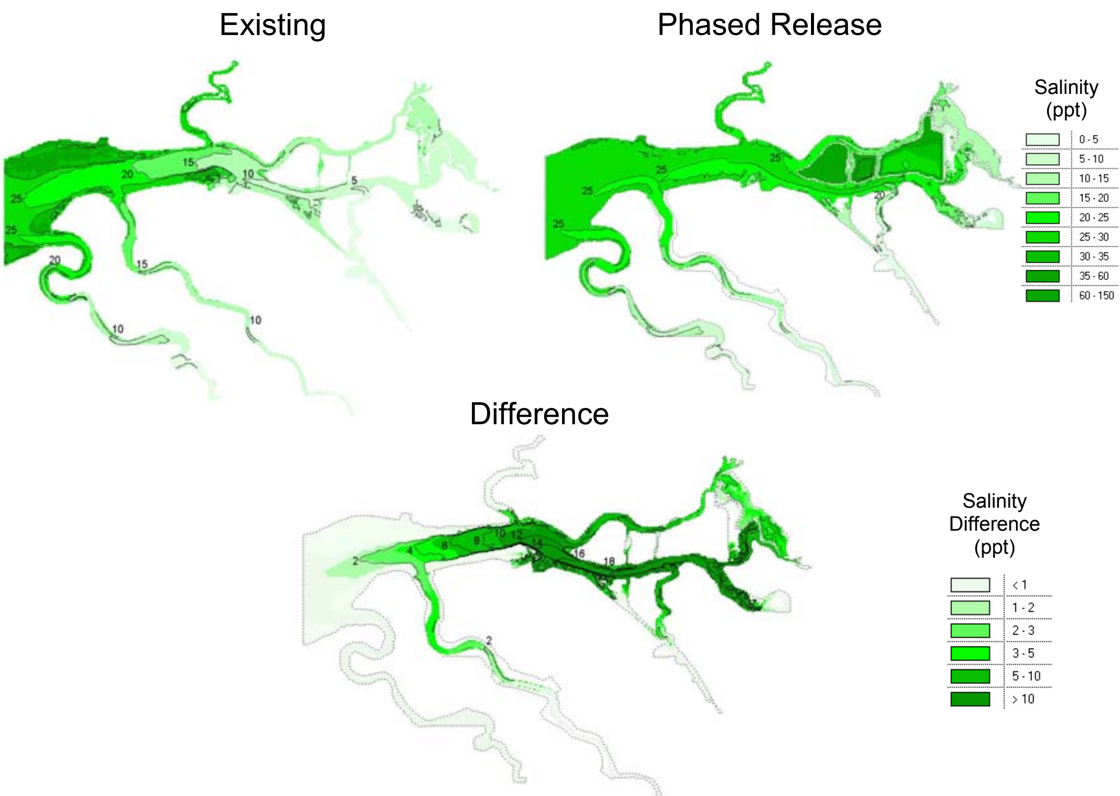
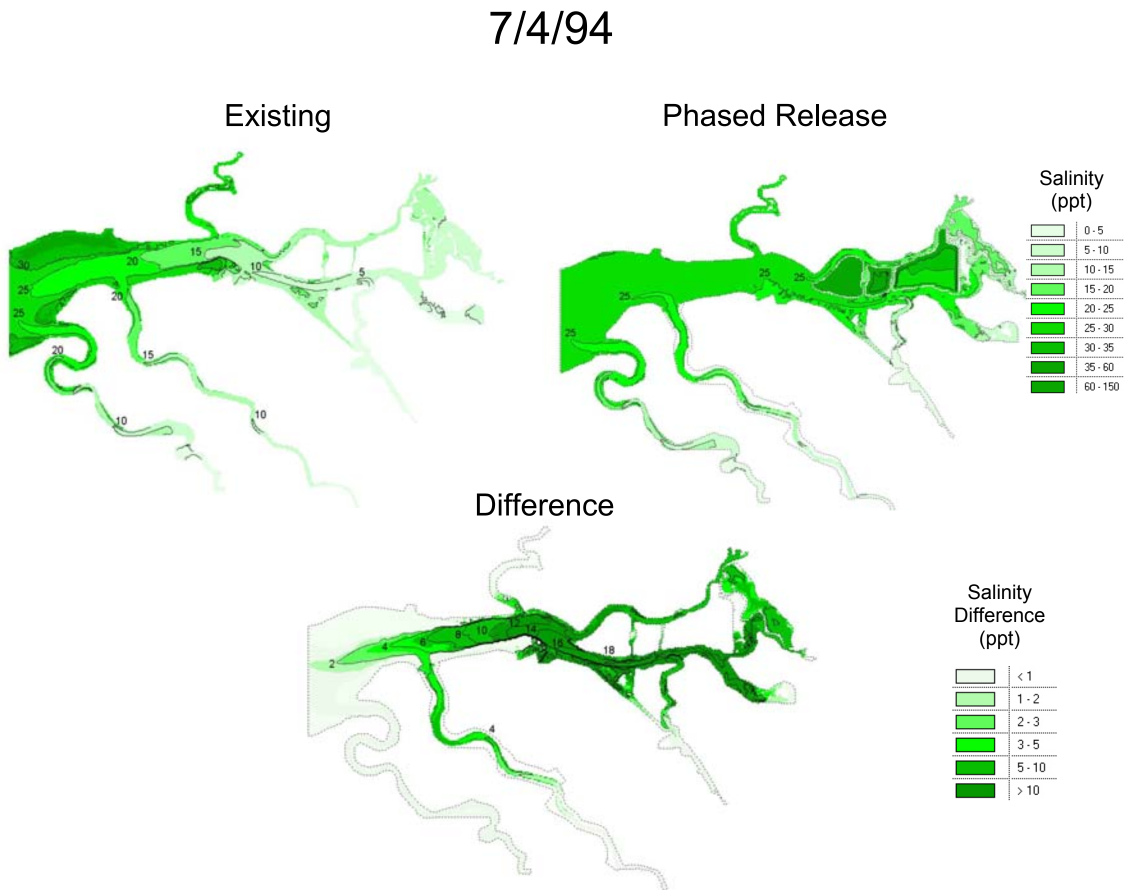


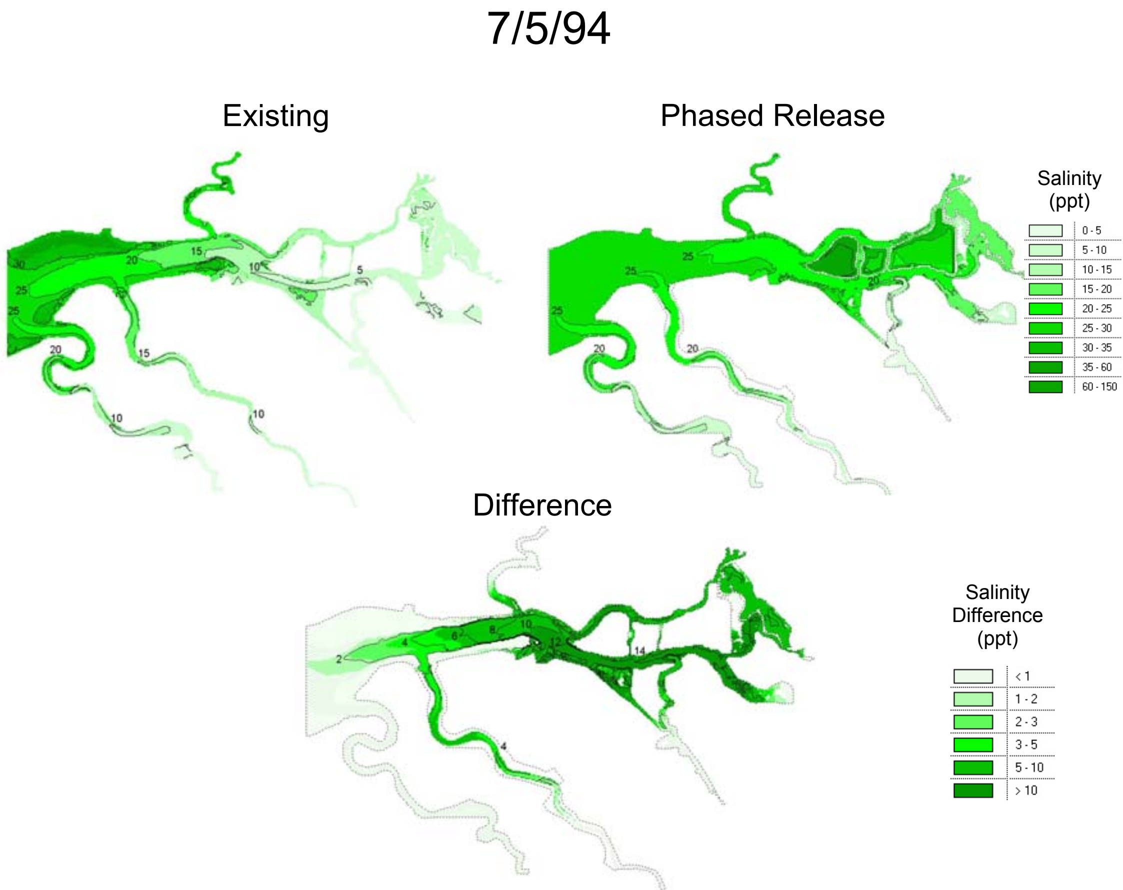
Note: Salinity map of Alviso Region indicates predicted depth-averaged and daily averaged salinity in each grid cell of the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.2-6 Predicted Alviso Region Salinity Comparison - Existing Conditions and Breach at 0 ft NGVD Scenario on July 3, the Third Day of the Initial Breach Period



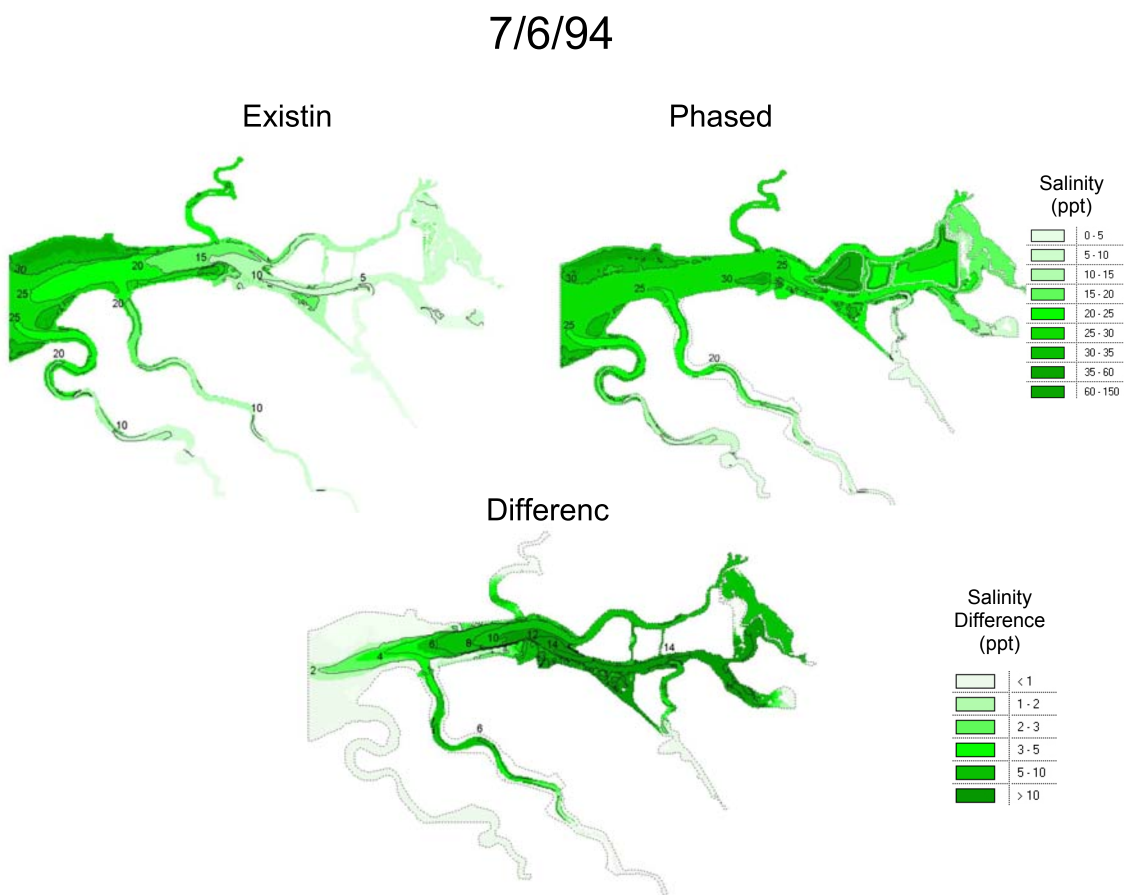
Note: Salinity map of Alviso Region indicates predicted depth-averaged and daily averaged salinity in each grid cell of the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.2-7 Predicted Alviso Region Salinity Comparison - Existing Conditions and Breach at 0 ft NGVD Scenario on July 4, the Fourth Day of the Initial Breach Period



Note: Salinity map of Alviso Region indicates predicted depth-averaged and daily averaged salinity in each grid cell of the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

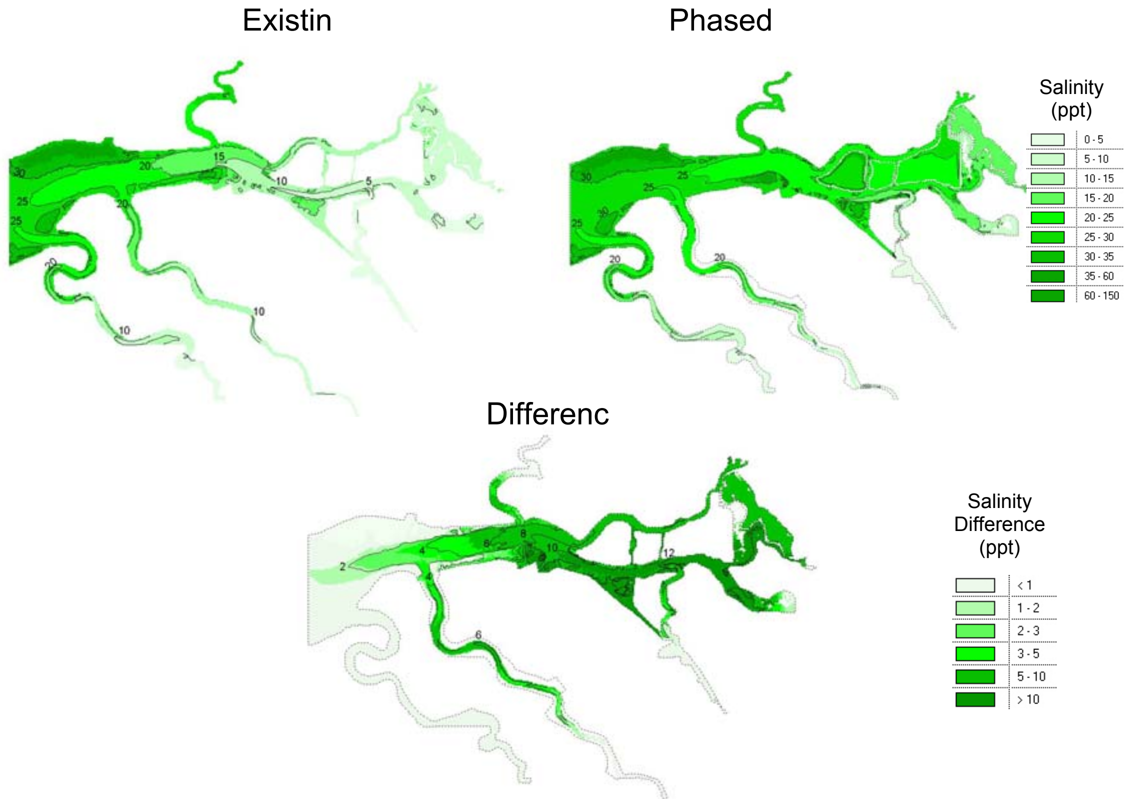
Figure 5.2-8 Predicted Alviso Region Salinity Comparison - Existing Conditions and Breach at 0 ft NGVD Scenario on July 5, the Fifth Day of the Initial Breach Period



Note: Salinity map of Alviso Region indicates predicted depth-averaged and daily averaged salinity in each grid cell of the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.2-9 Predicted Alviso Region Salinity Comparison - Existing Conditions and Breach at 0 ft NGVD Scenario on July 6, the Sixth Day of the Initial Breach Period

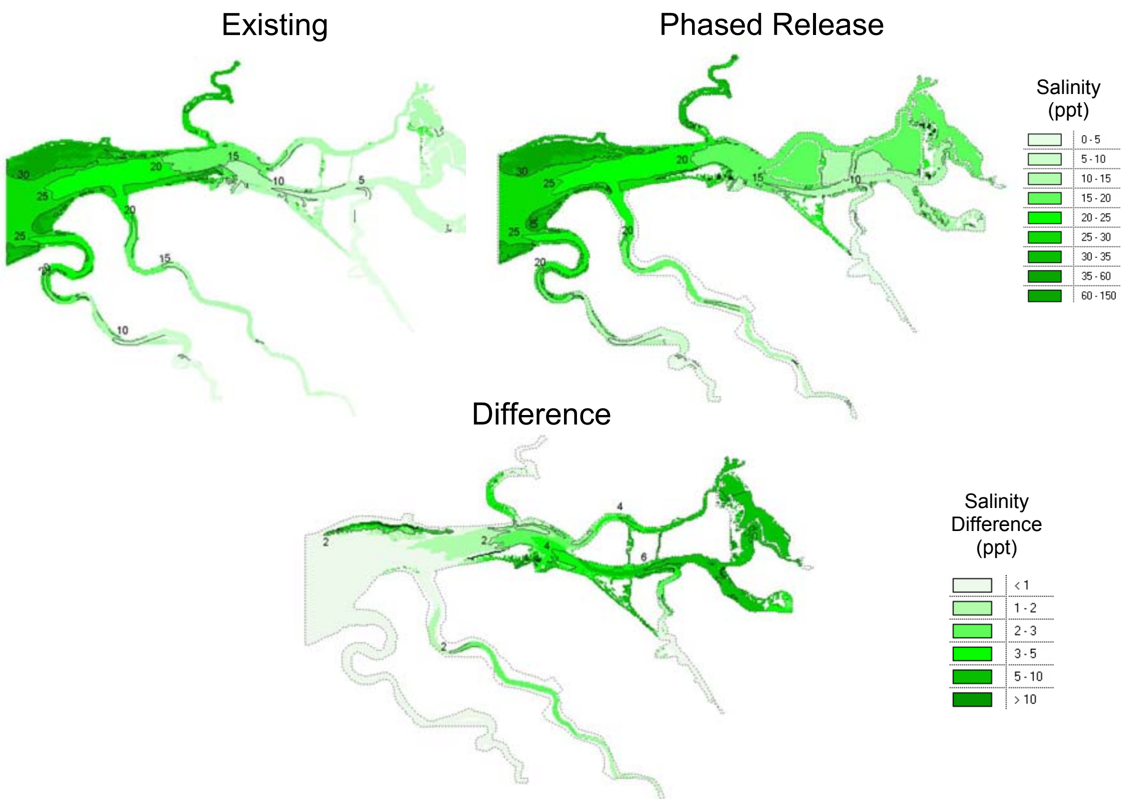
7/7/94



Note: Salinity map of Alviso Region indicates predicted depth-averaged and daily averaged salinity in each grid cell of the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

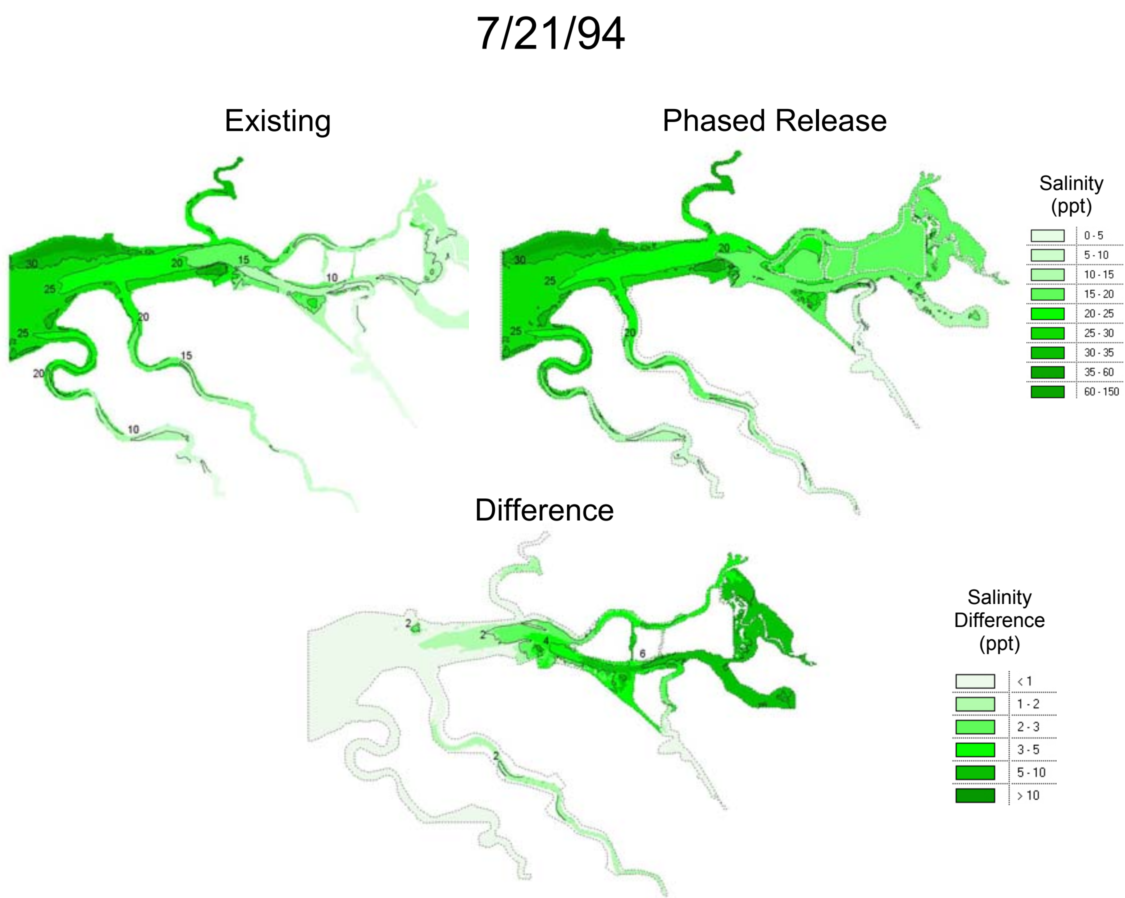
Figure 5.2-10 Predicted Alviso Region Salinity Comparison - Existing Conditions and Breach at 0 ft NGVD Scenario on July 7, One Week into the Initial Breach Period

7/14/94



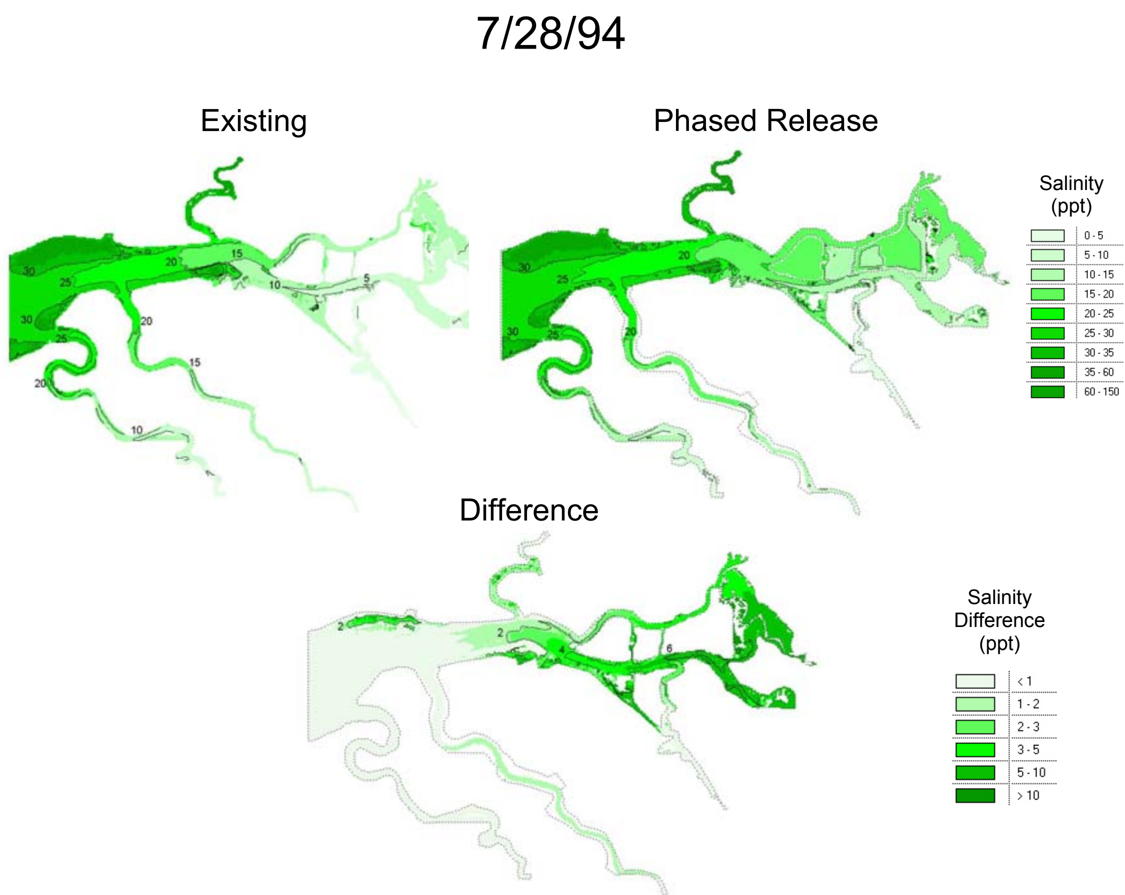
Note: Salinity map of Alviso Region indicates predicted depth-averaged and daily averaged salinity in each grid cell of the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.2-11 Predicted Alviso Region Salinity Comparison - Existing Conditions and Breach at 0 ft NGVD Scenario on July 14, Two Weeks into the Initial Breach Period



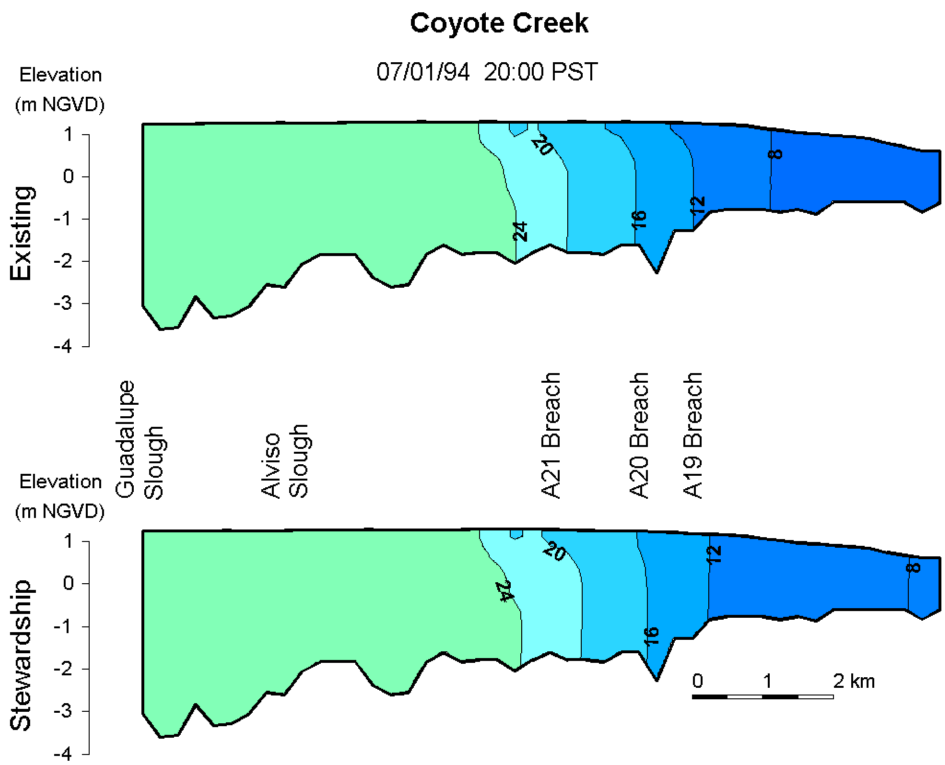
Note: Salinity map of Alviso Region indicates predicted depth-averaged and daily averaged salinity in each grid cell of the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.2-12 Predicted Alviso Region Salinity Comparison - Existing Conditions and Breach at 0 ft NGVD Scenario on July 21, Three Weeks into the Initial Breach Period



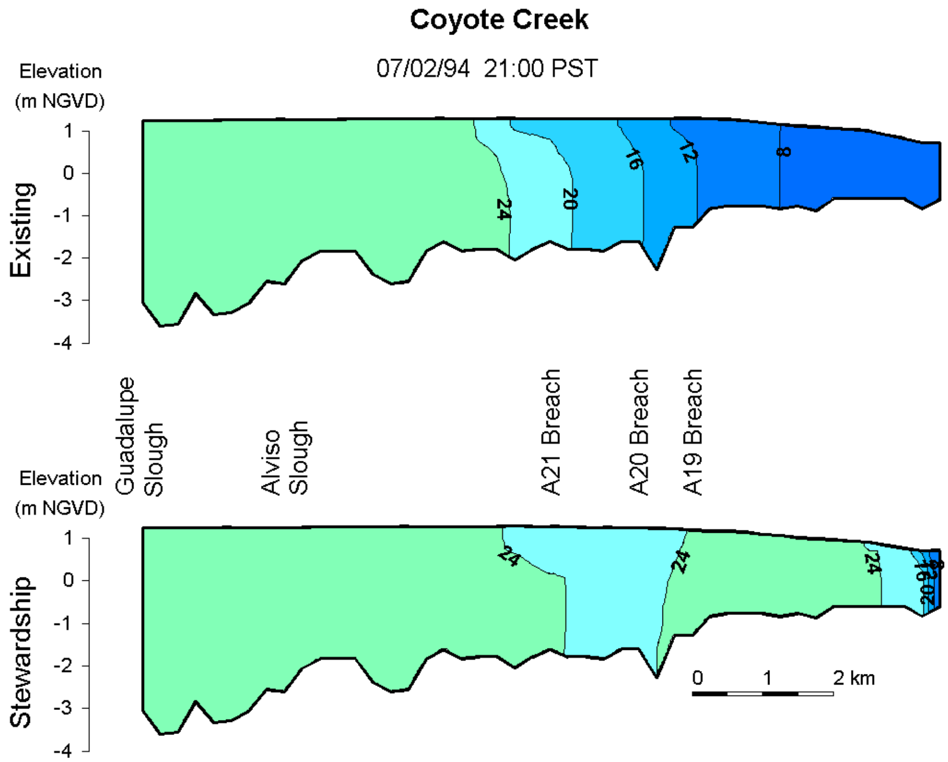
Note: Salinity map of Alviso Region indicates predicted depth-averaged and daily averaged salinity in each grid cell of the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.2-13 Predicted Alviso Region Salinity Comparison - Existing Conditions and Breach at 0 ft NGVD Scenario on July 28, Four Weeks into the Initial Breach Period



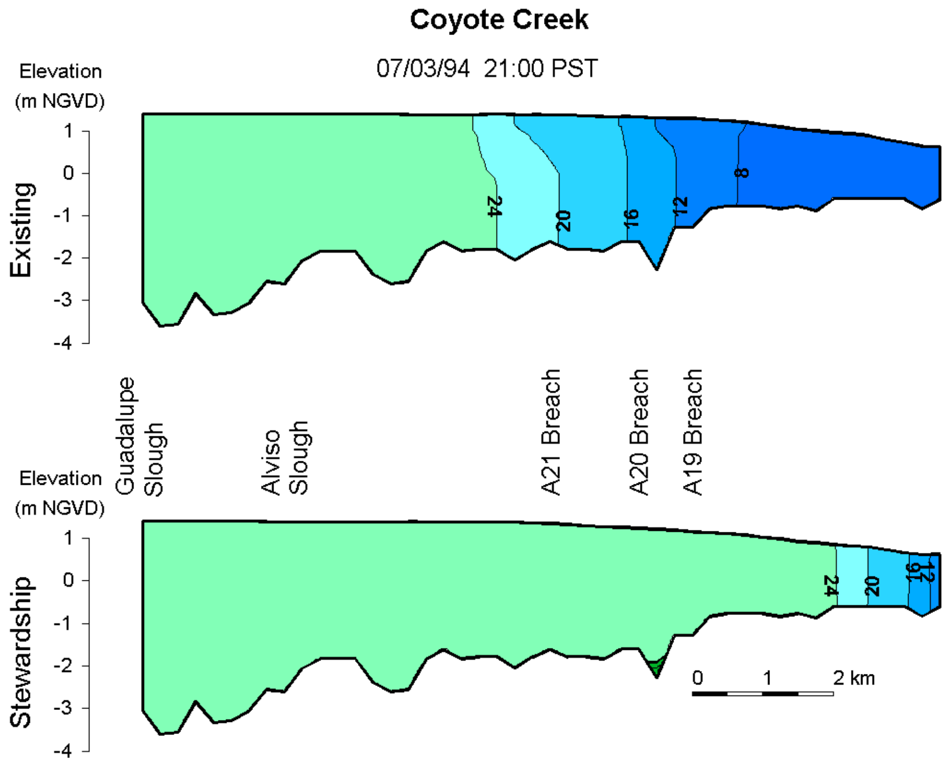
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.2-14 Predicted Coyote Creek Salinity Comparison - Existing Conditions and Breach at 0 ft NGVD Scenario on July 1, the First Day of the Initial Breach Period



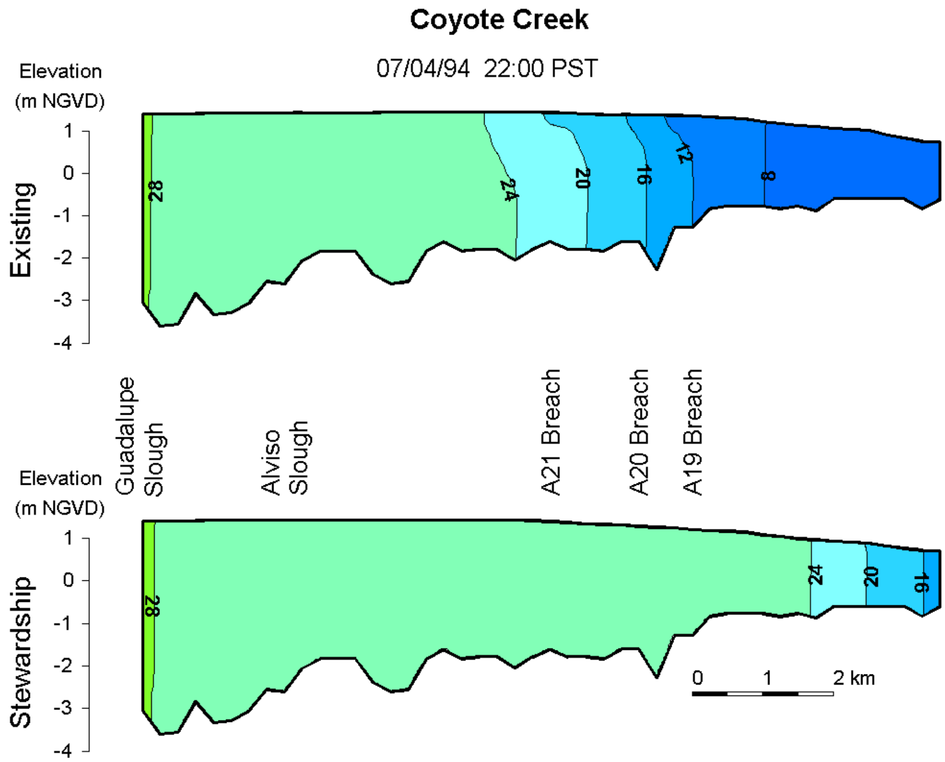
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.2-15 Predicted Coyote Creek Salinity Comparison - Existing Conditions and Breach at 0 ft NGVD Scenario on July 2, the Second Day of the Initial Breach Period



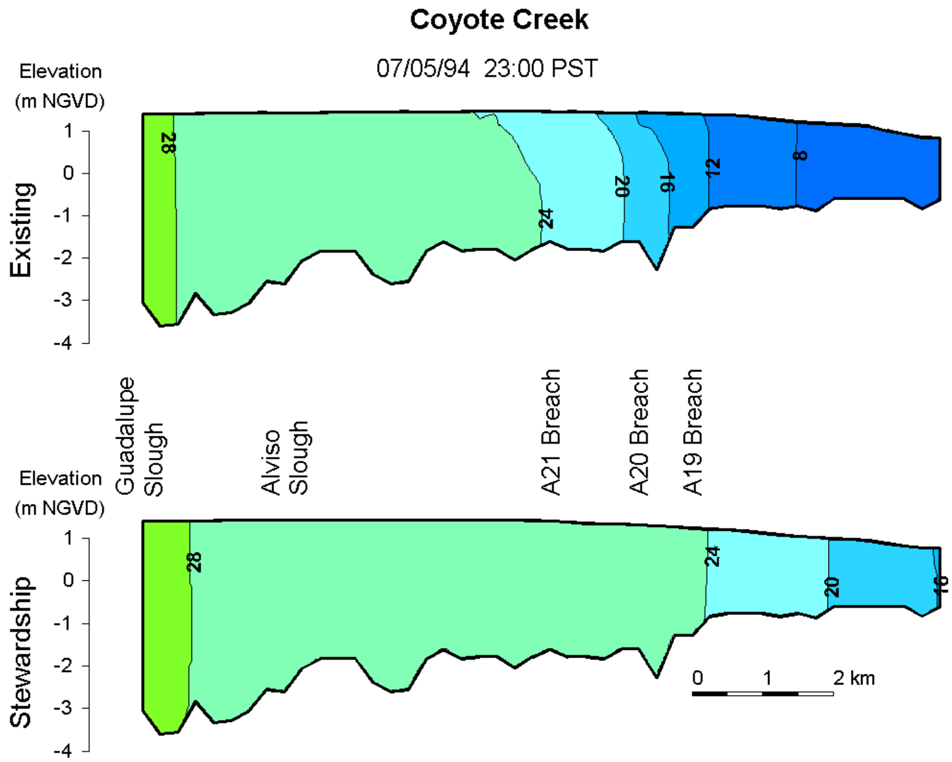
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.2-16 Predicted Coyote Creek Salinity Comparison - Existing Conditions and Breach at 0 ft NGVD Scenario on July 3, the Third Day of the Initial Breach Period



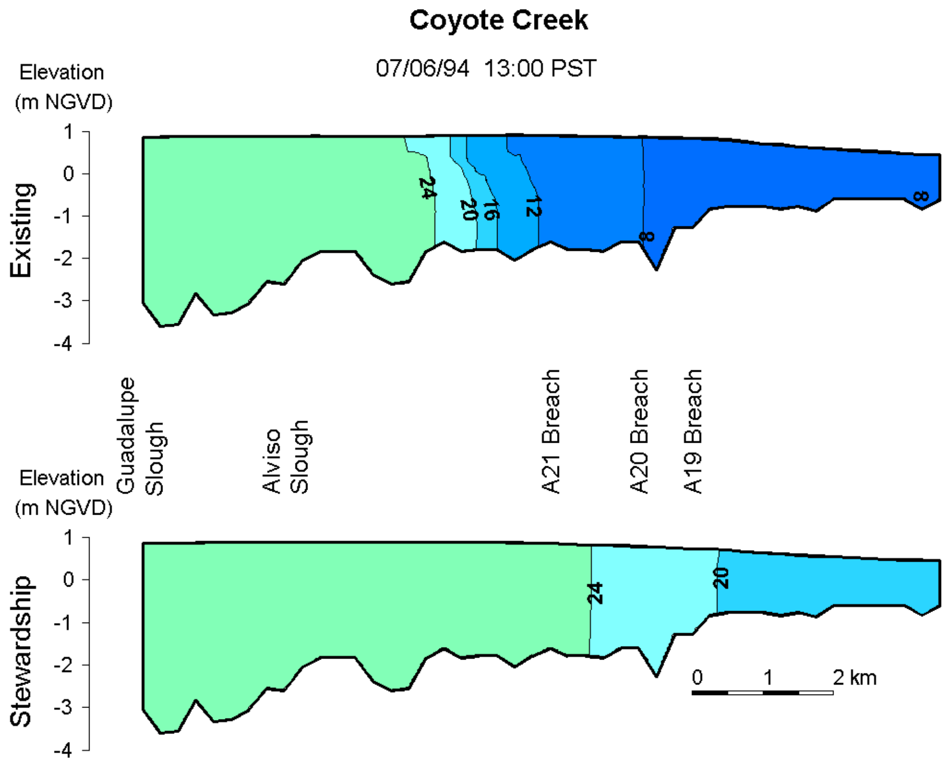
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.2-17 Predicted Coyote Creek Salinity Comparison - Existing Conditions and Breach at 0 ft NGVD Scenario on July 4, the Fourth Day of the Initial Breach Period



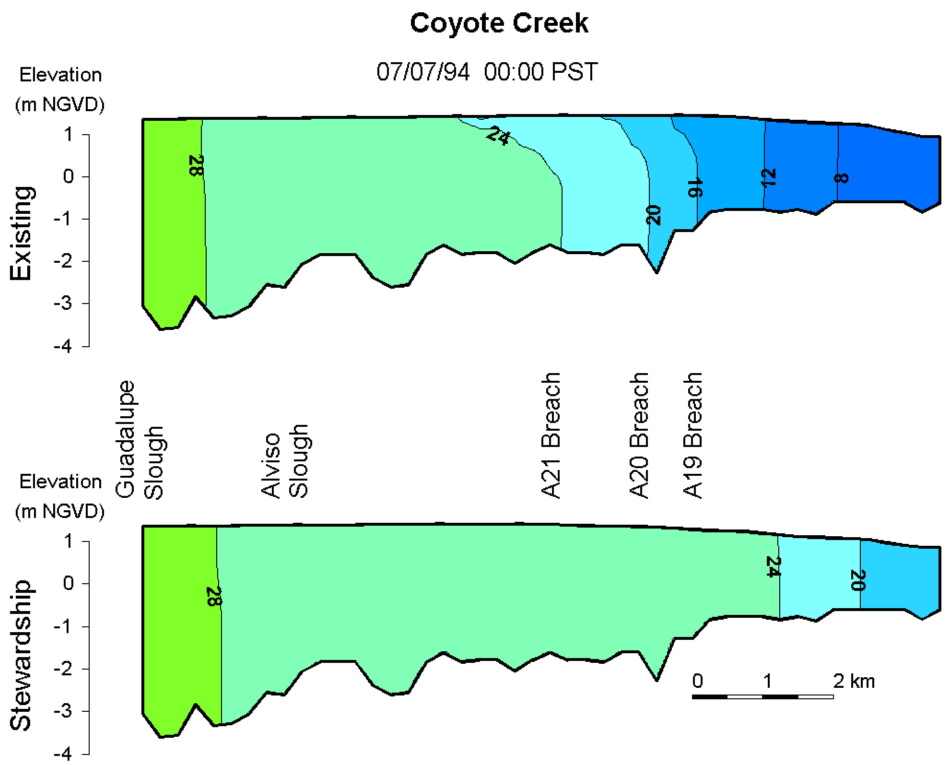
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.2-18 Predicted Coyote Creek Salinity Comparison - Existing Conditions and Breach at 0 ft NGVD Scenario on July 5, the Fifth Day of the Initial Breach Period



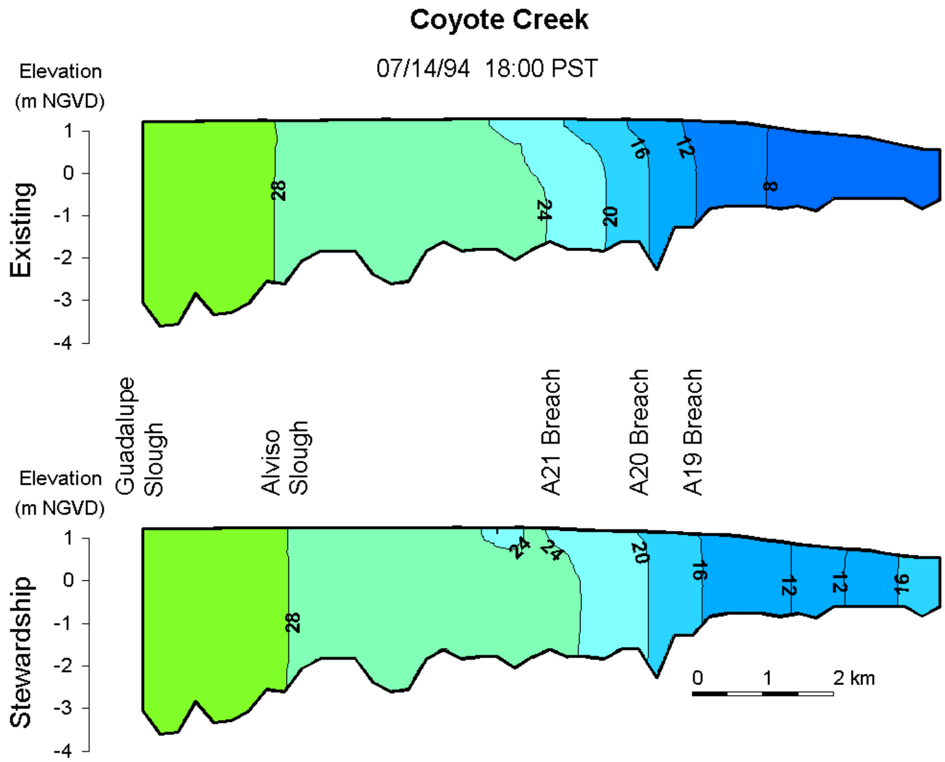
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.2-19 Predicted Coyote Creek Salinity Comparison - Existing Conditions and Breach at 0 ft NGVD Scenario on July 6, the Sixth Day of the Initial Breach Period



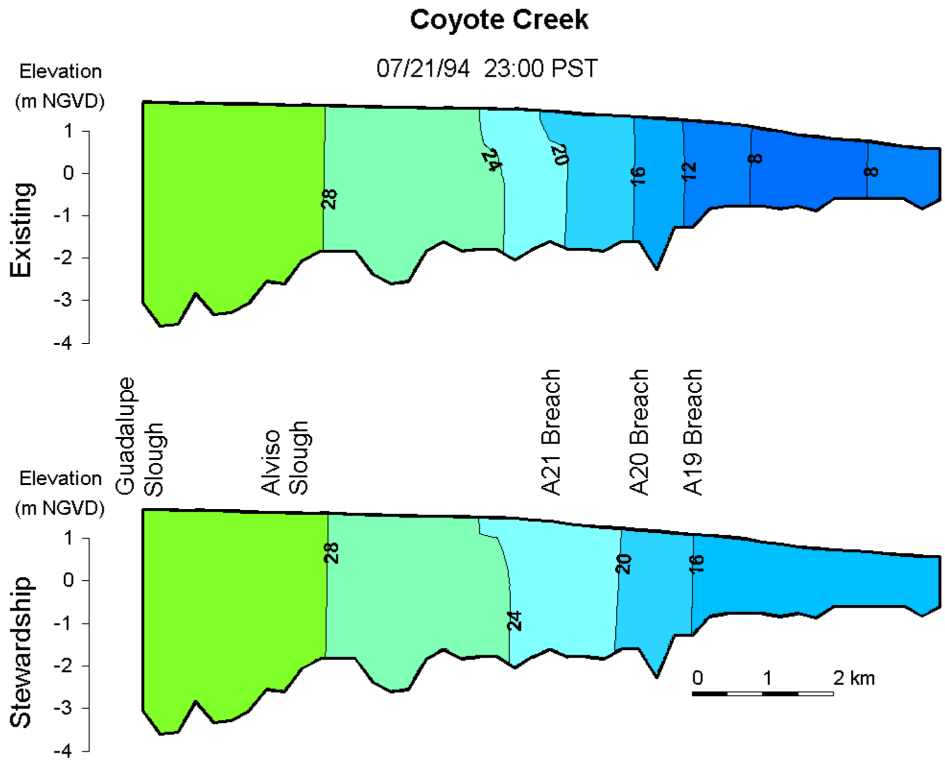
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.2-20 Predicted Coyote Creek Salinity Comparison - Existing Conditions and Breach at 0 ft NGVD Scenario on July 7, One Week into the Initial Breach Period



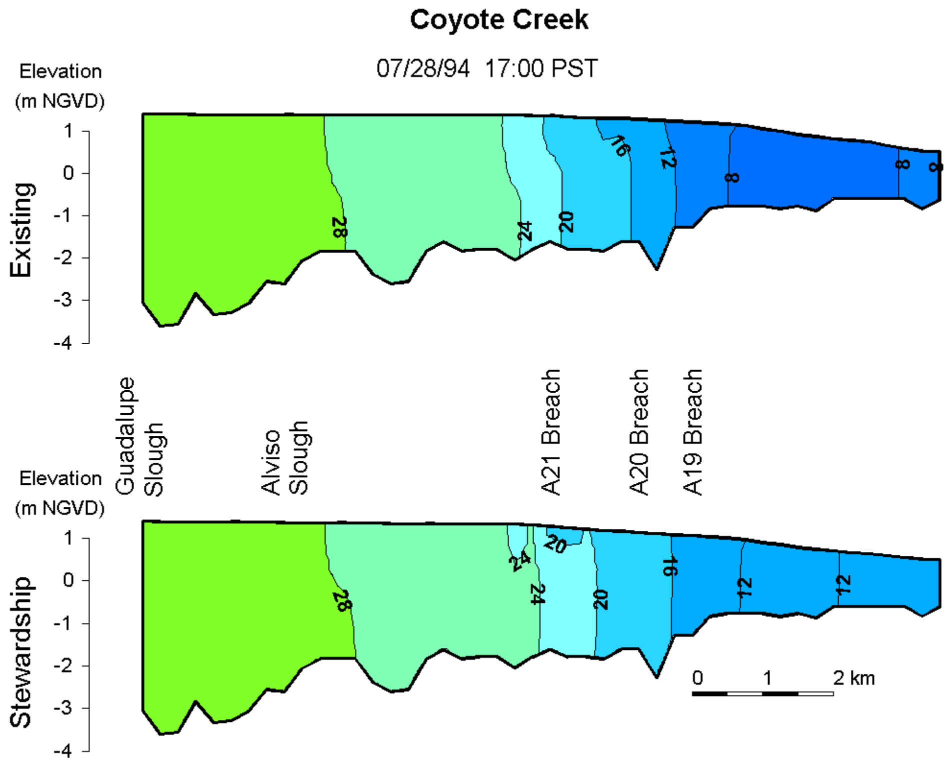
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.2-21 Predicted Coyote Creek Salinity Comparison - Existing Conditions and Breach at 0 ft NGVD Scenario on July 14, Two Weeks into the Initial Breach Period



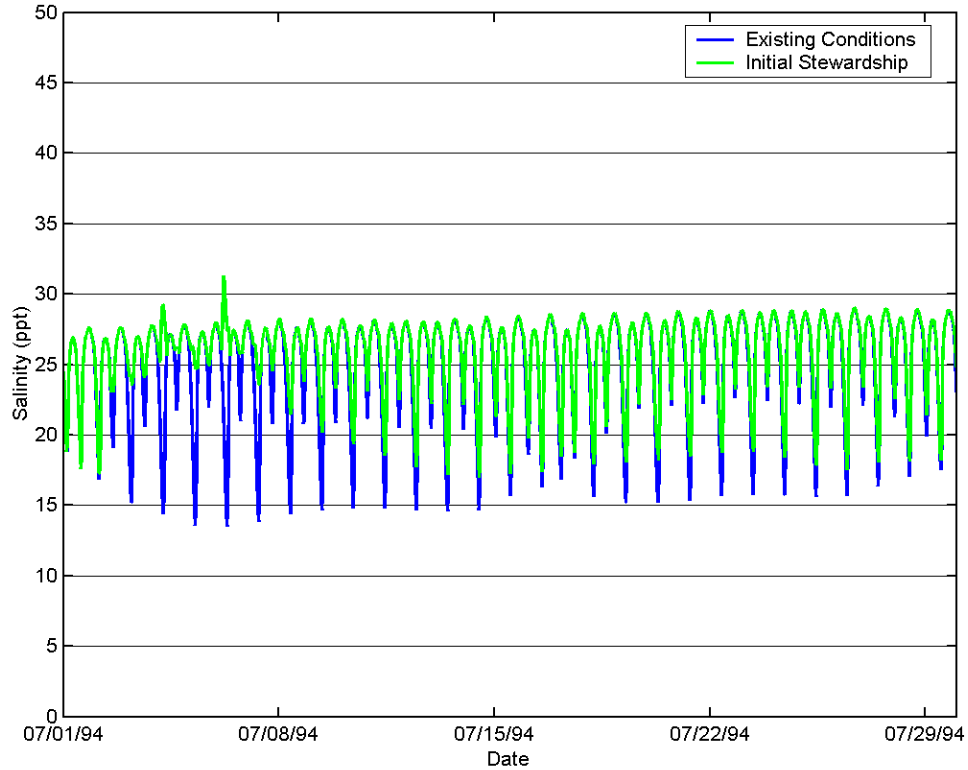
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.2-22 Predicted Coyote Creek Salinity Comparison - Existing Conditions and Breach at 0 ft NGVD Scenario on July 21, Three Weeks into the Initial Breach Period



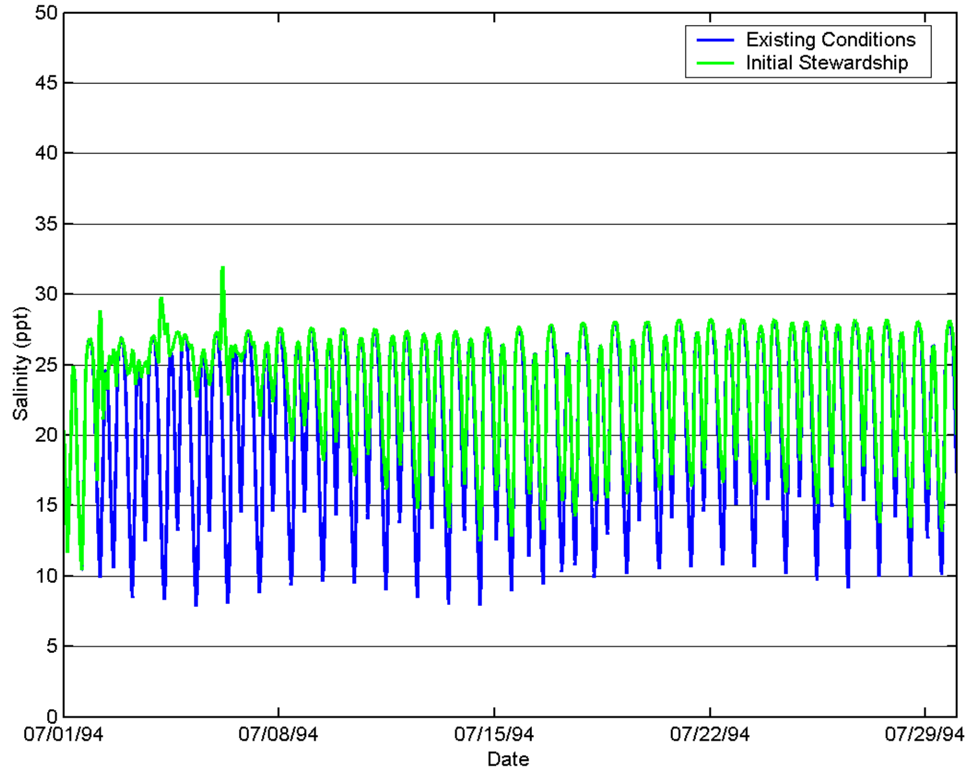
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.2-23 Predicted Coyote Creek Salinity Comparison - Existing Conditions and Breach at 0 ft NGVD Scenario on July 28, Four Weeks into the Initial Breach Period



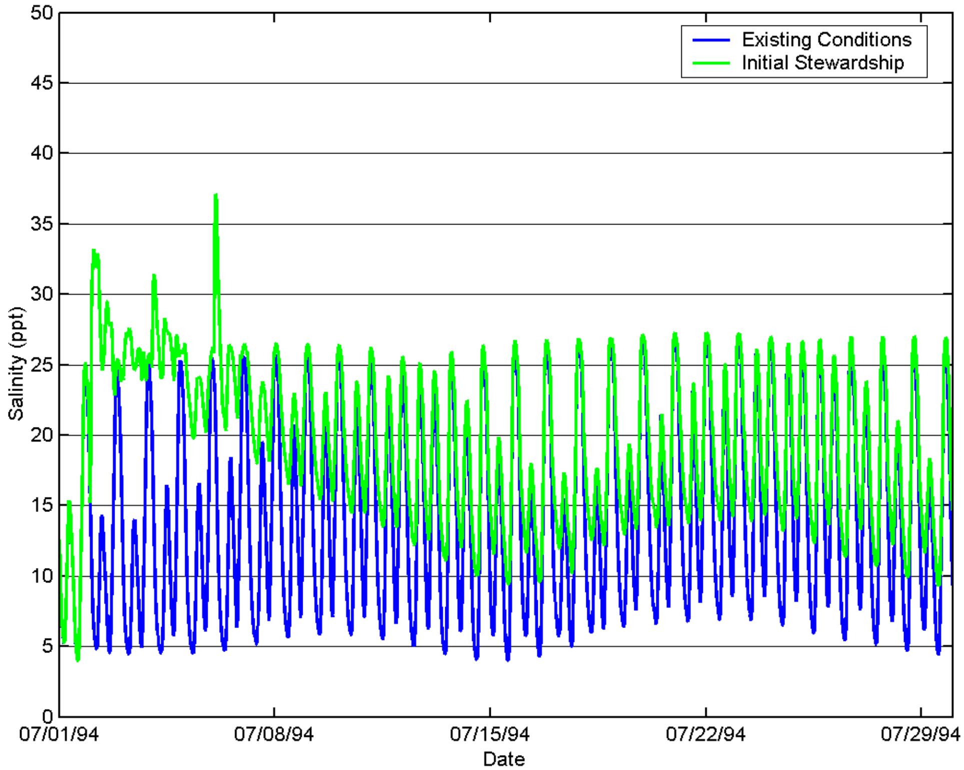
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.2-24 Predicted Coyote Creek 1 km Station Salinity – Existing Conditions and Breach at 0 ft NGVD Scenario for July, the First Month of the Initial Breach Period



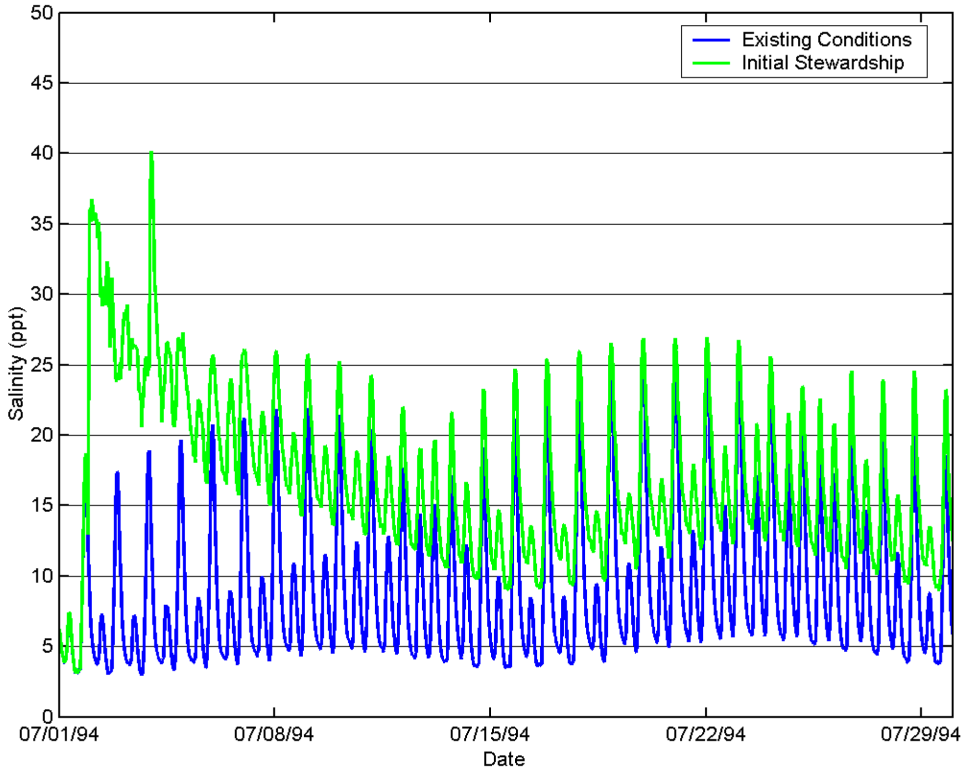
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.2-25 Predicted Coyote Creek 3 km Station Salinity – Existing Conditions and Breach at 0 ft NGVD Scenario for July, the First Month of the Initial Breach Period



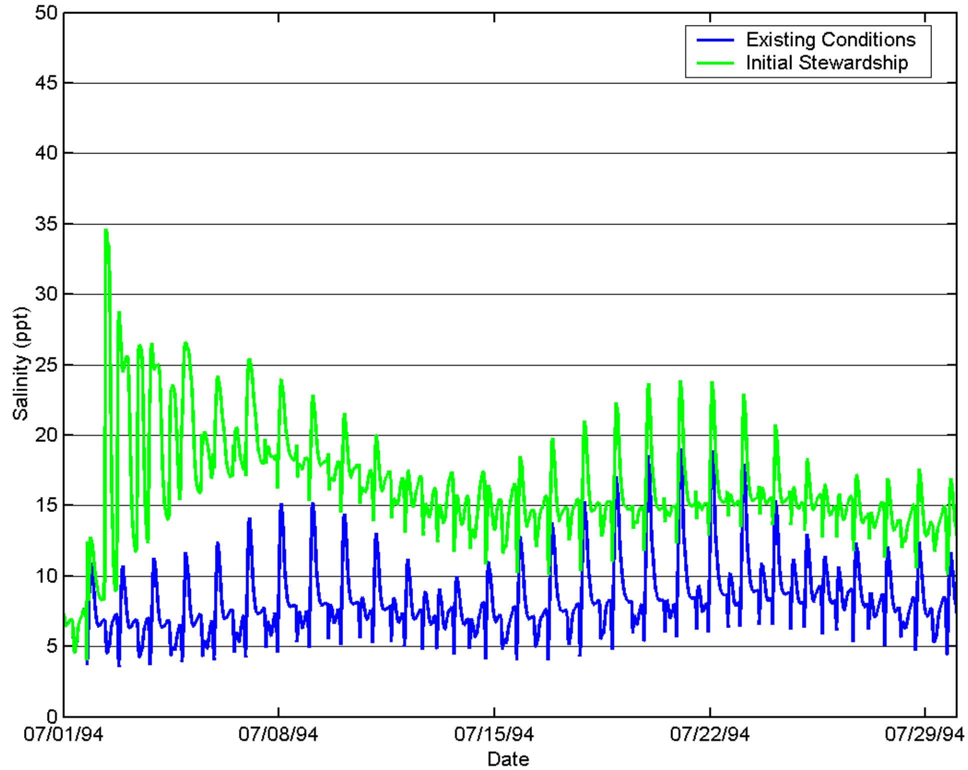
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.2-26 Predicted Coyote Creek 5 km Station Salinity – Existing Conditions and Breach at 0 ft NGVD Scenario for July, the First Month of the Initial Breach Period



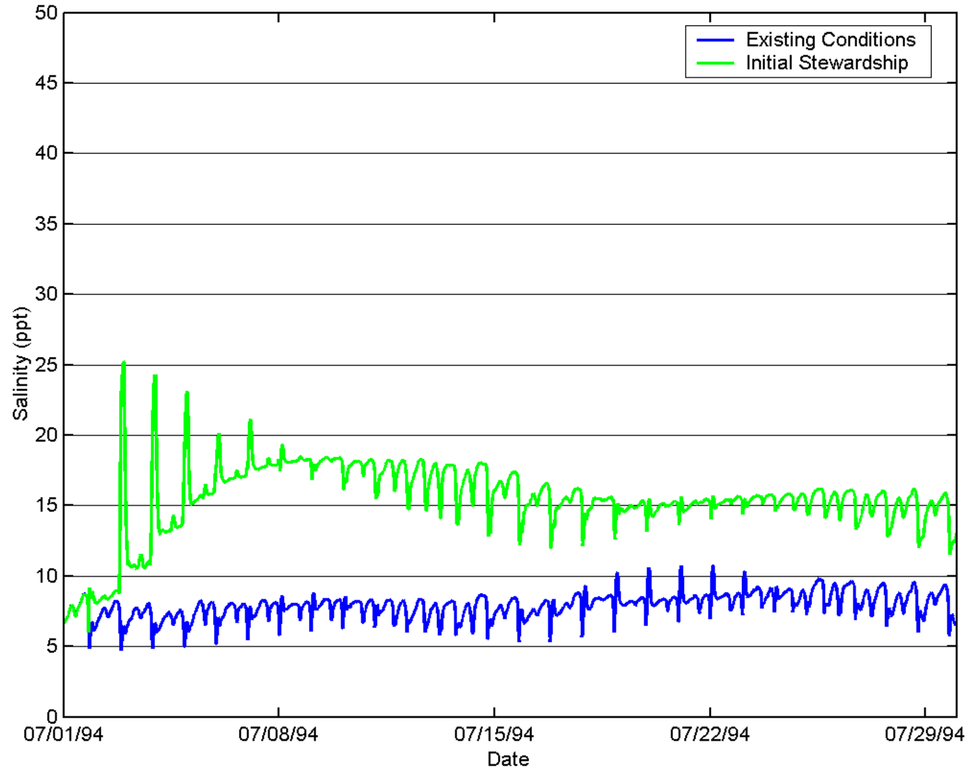
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.2-27 Predicted Coyote Creek 7 km Station Salinity – Existing Conditions and Breach at 0 ft NGVD Scenario for July, the First Month of the Initial Breach Period



Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.2-28 Predicted Coyote Creek 9 km Station Salinity – Existing Conditions and Breach at 0 ft NGVD Scenario for July, the First Month of the Initial Breach Period



Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994-1995 weather and tidal conditions.

Figure 5.2-29 Predicted Coyote Creek 11 km Station Salinity – Existing Conditions and Breach at 0 ft NGVD Scenario for July, the First Month of the Initial Breach Period

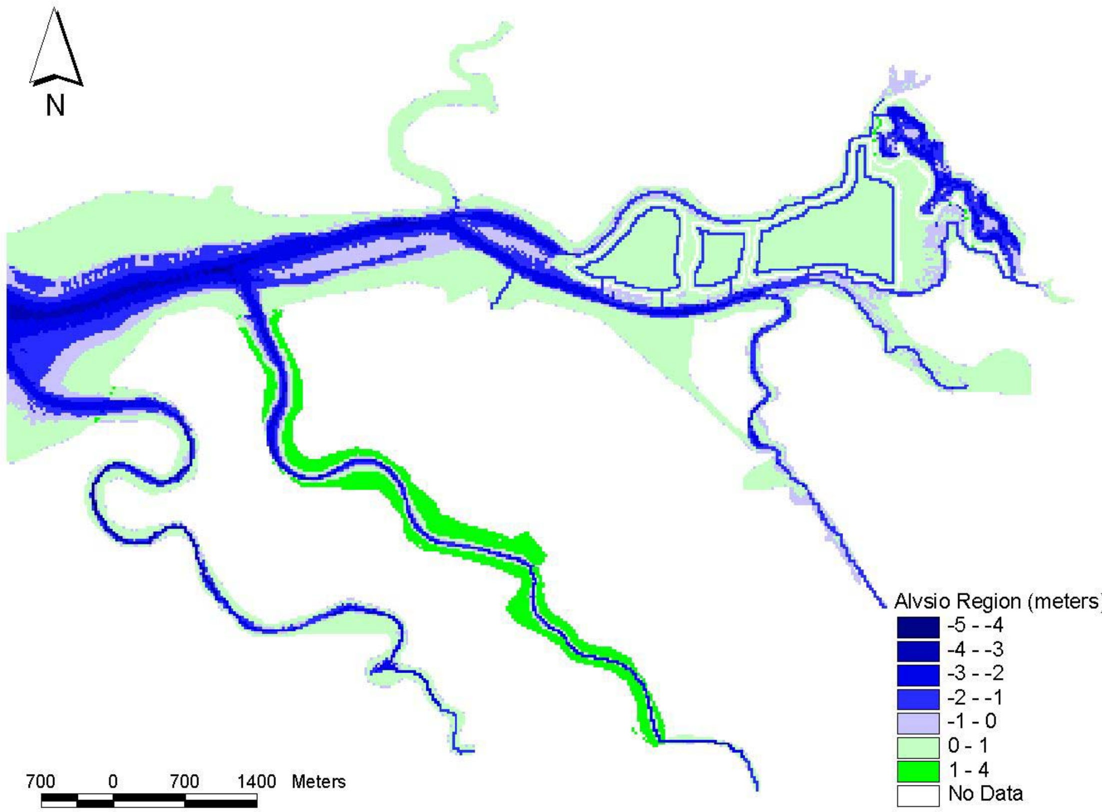
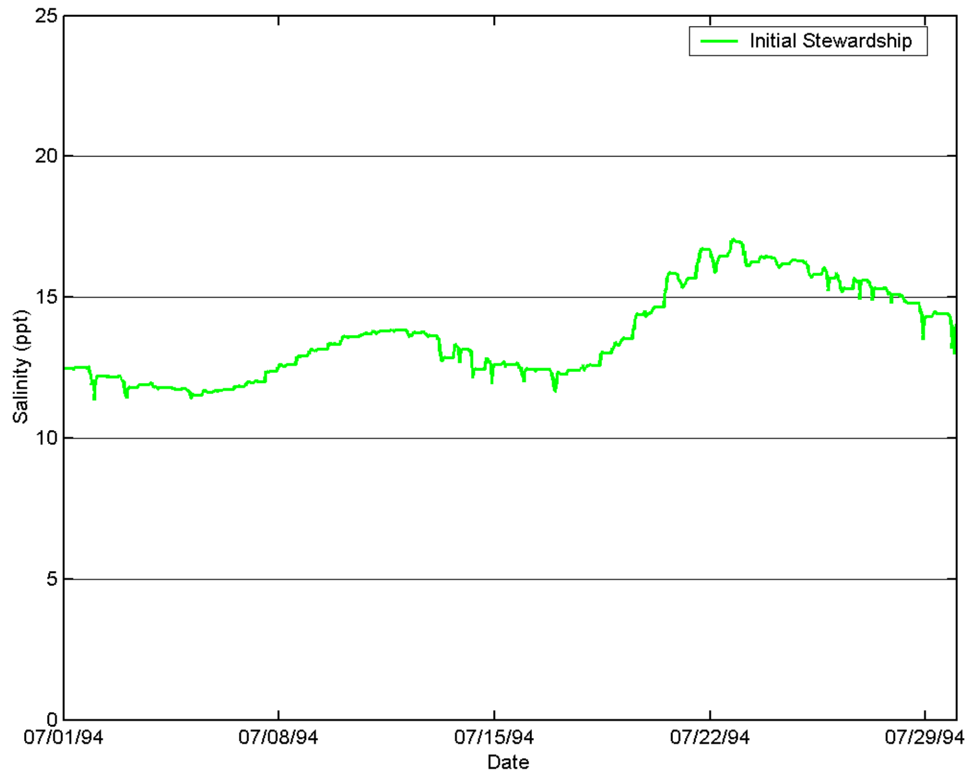
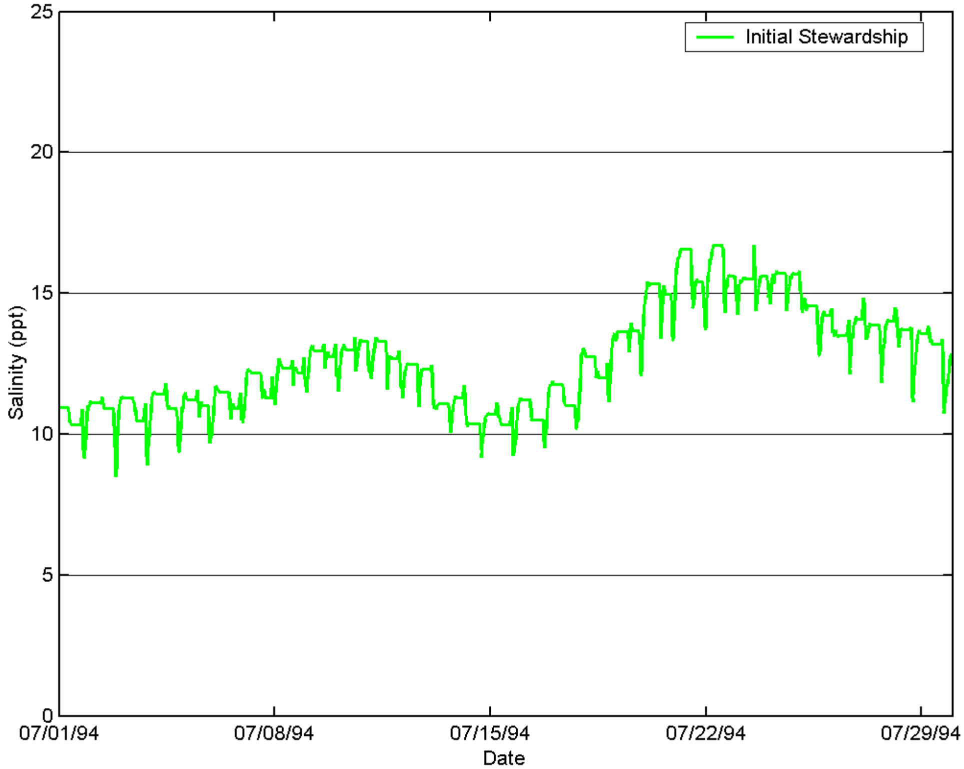


Figure 6-1 Alviso Region Bathymetry with Island Ponds and Long Term Breach Geometry



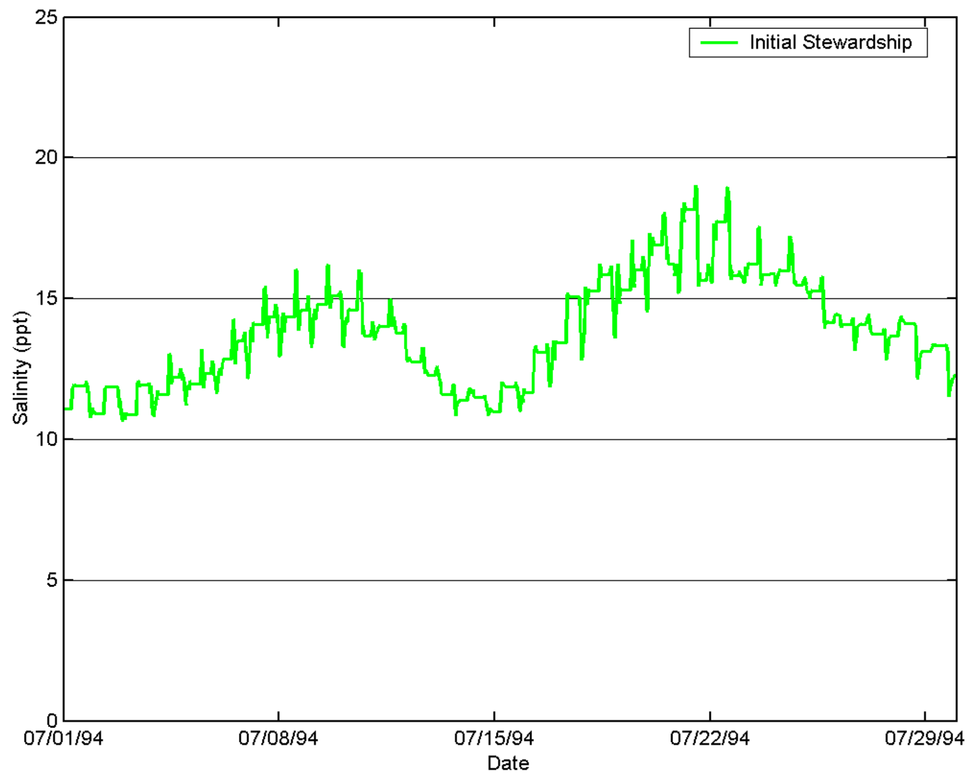
Note: Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.1-1 Predicted Alviso A19 Salinity for Long Term Breach Scenario



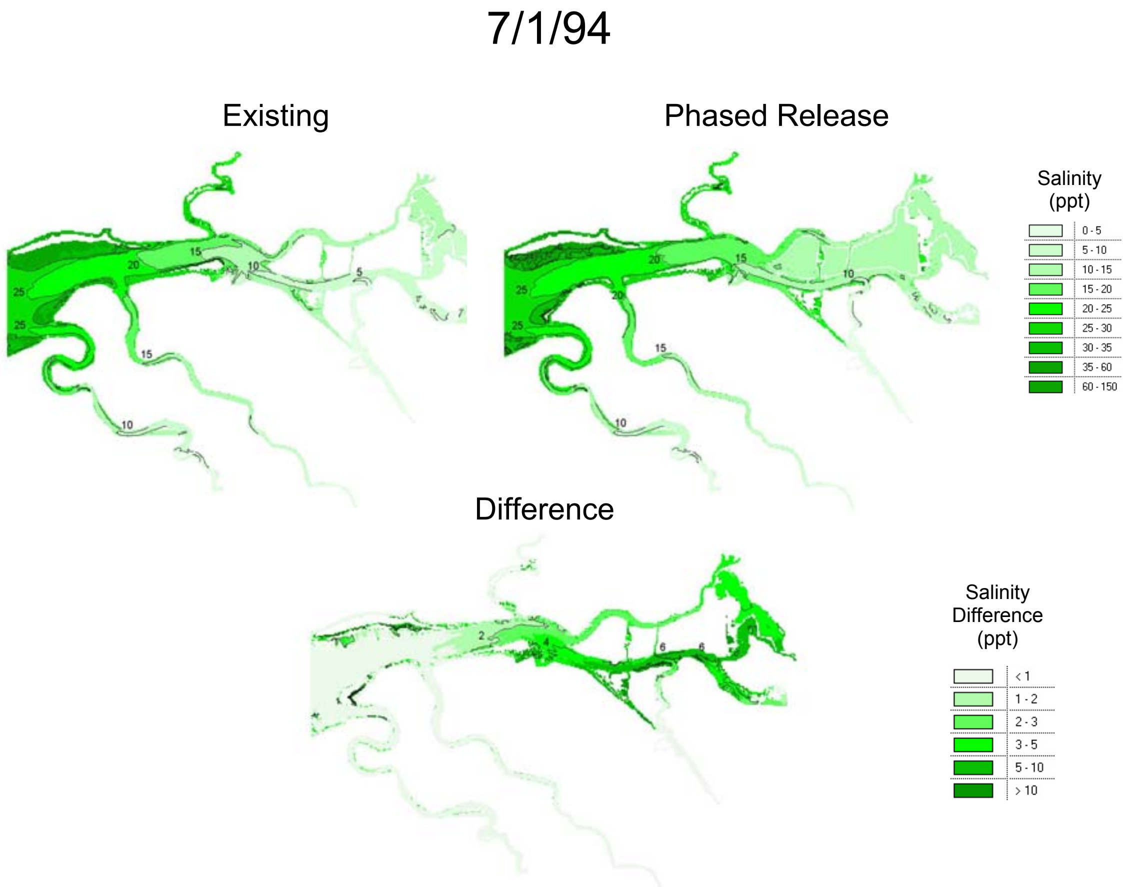
Note: Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.1-2 Predicted Alviso A20 Salinity for Long Term Breach Scenario



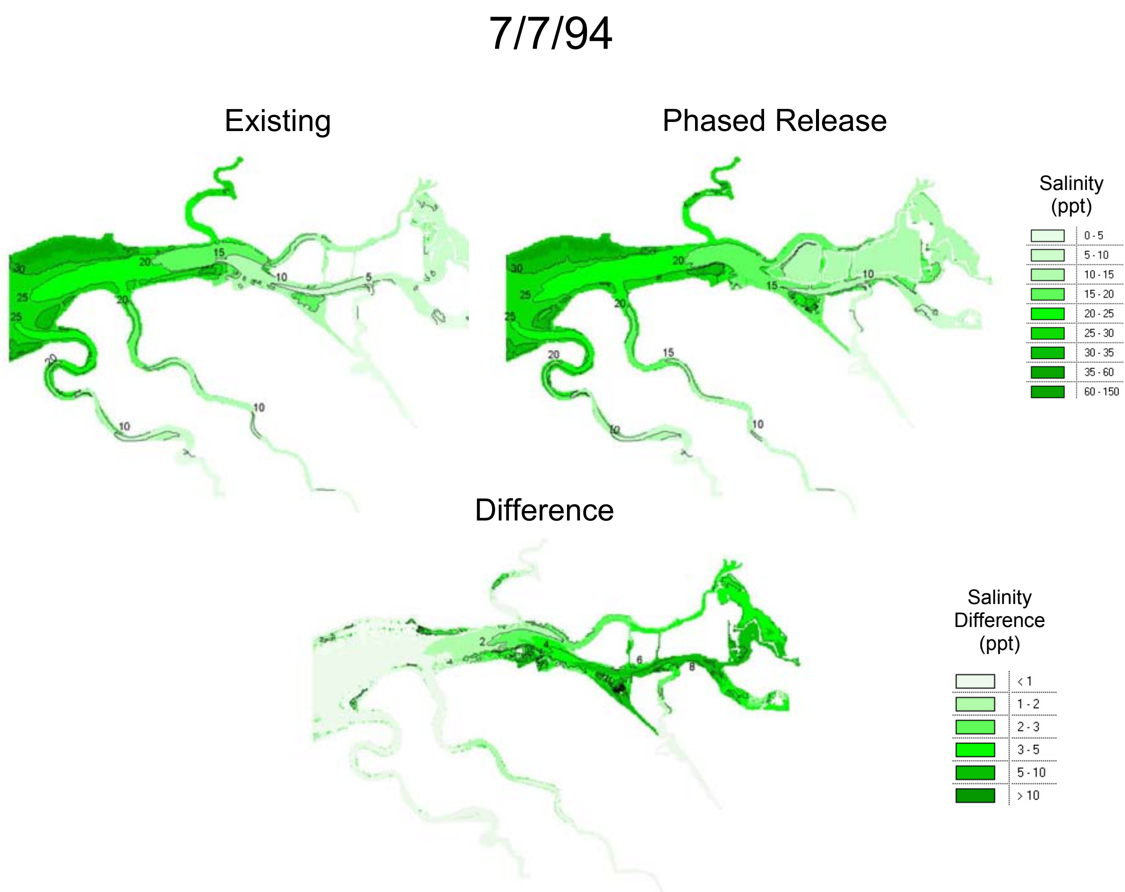
Note: Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.1-3 Predicted Alviso A21 Salinity for Long Term Breach Scenario



Note: Salinity map of Alviso Region indicates predicted depth-averaged and daily averaged salinity in each grid cell of the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.1-4 Predicted Alviso Region Salinity Comparison - Existing Conditions and Long Term Breach Scenario on July 1



Note: Salinity map of Alviso Region indicates predicted depth-averaged and daily averaged salinity in each grid cell of the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.1-5 Predicted Alviso Region Salinity Comparison - Existing Conditions and Long Term Breach Scenario on July 7

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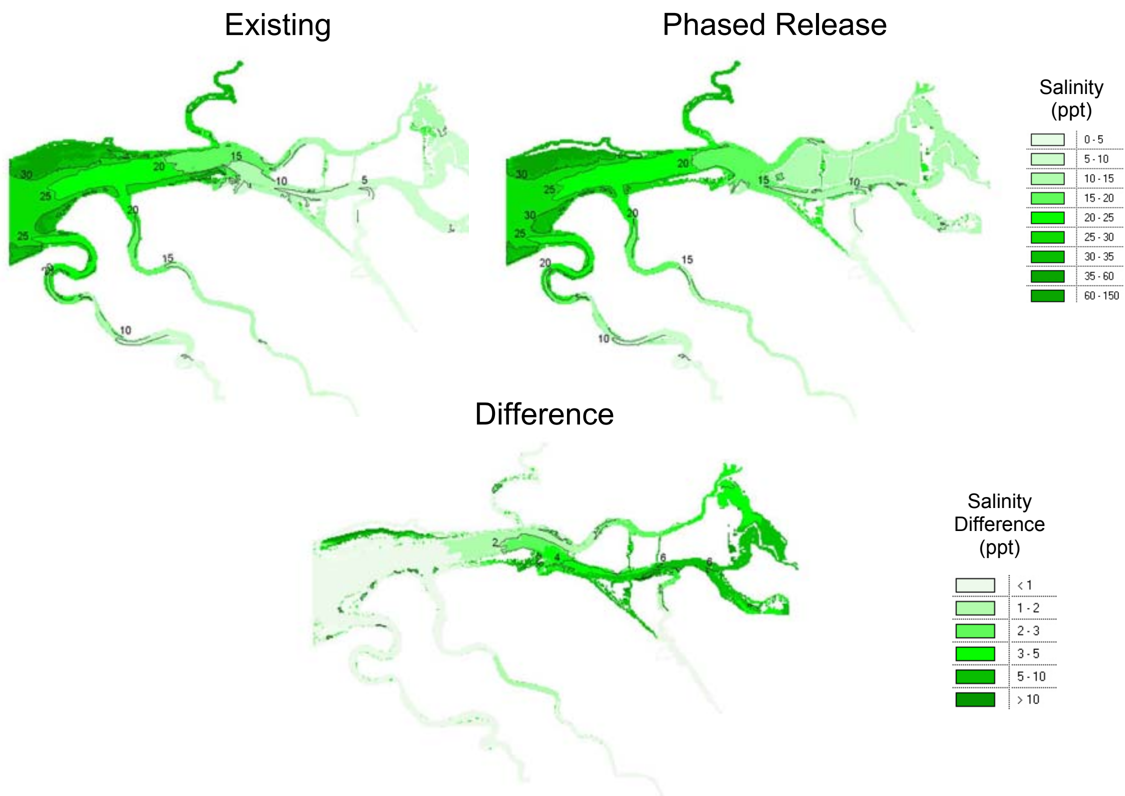
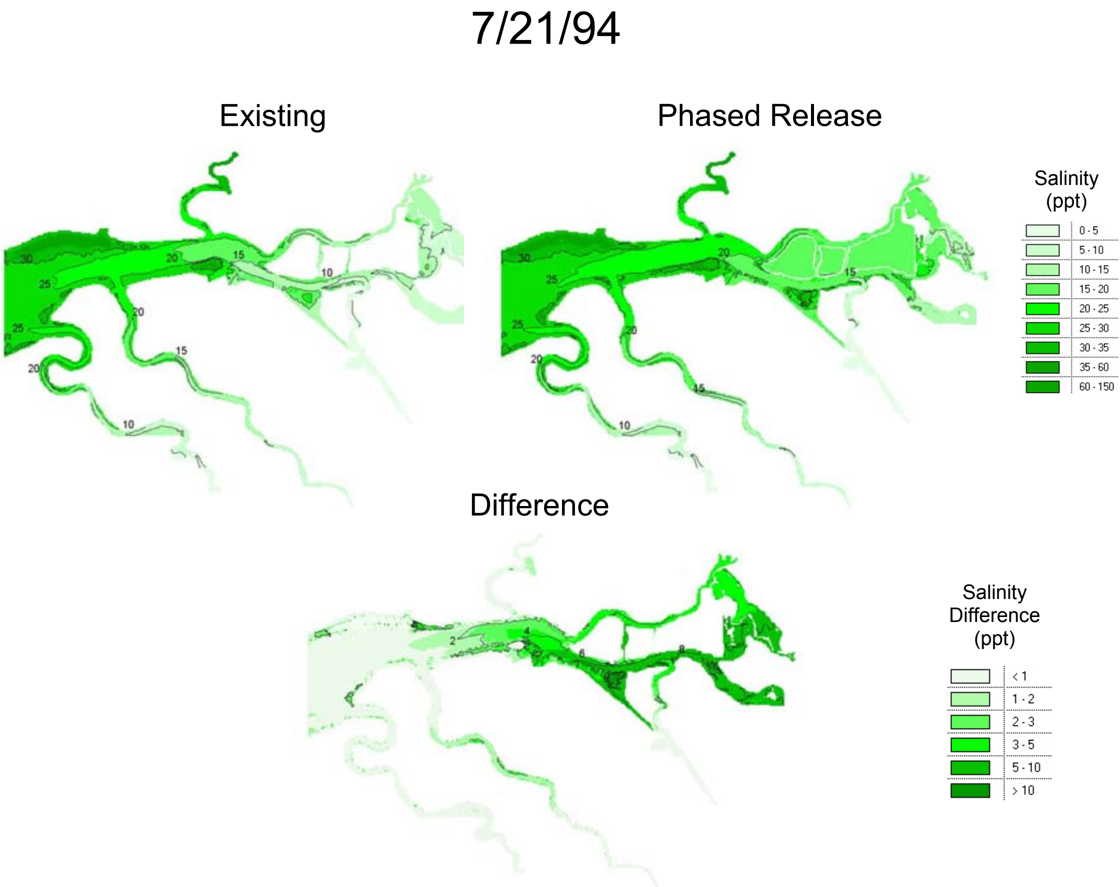


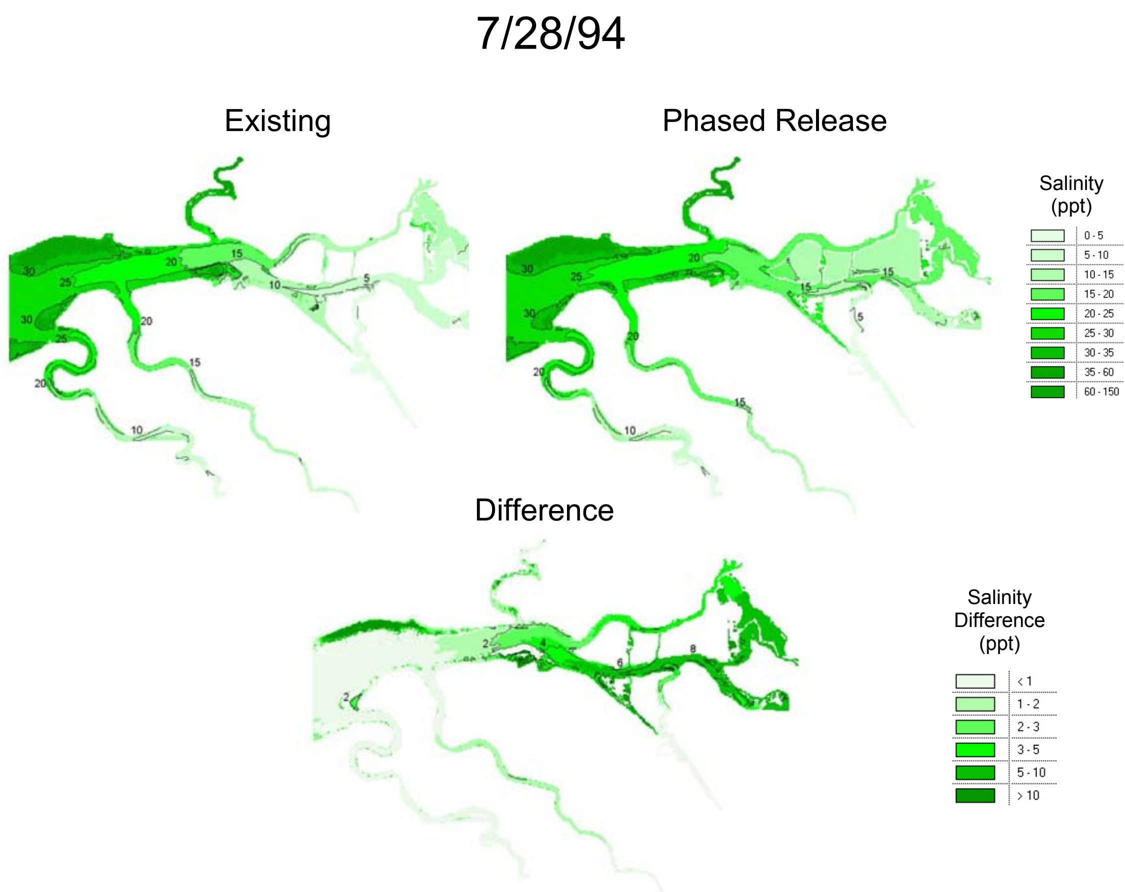
Note: Salinity map of Alviso Region indicates predicted depth-averaged and daily averaged salinity in each grid cell of the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.1-6 Predicted Alviso Region Salinity Comparison - Existing Conditions and Long Term Breach Scenario on July 14



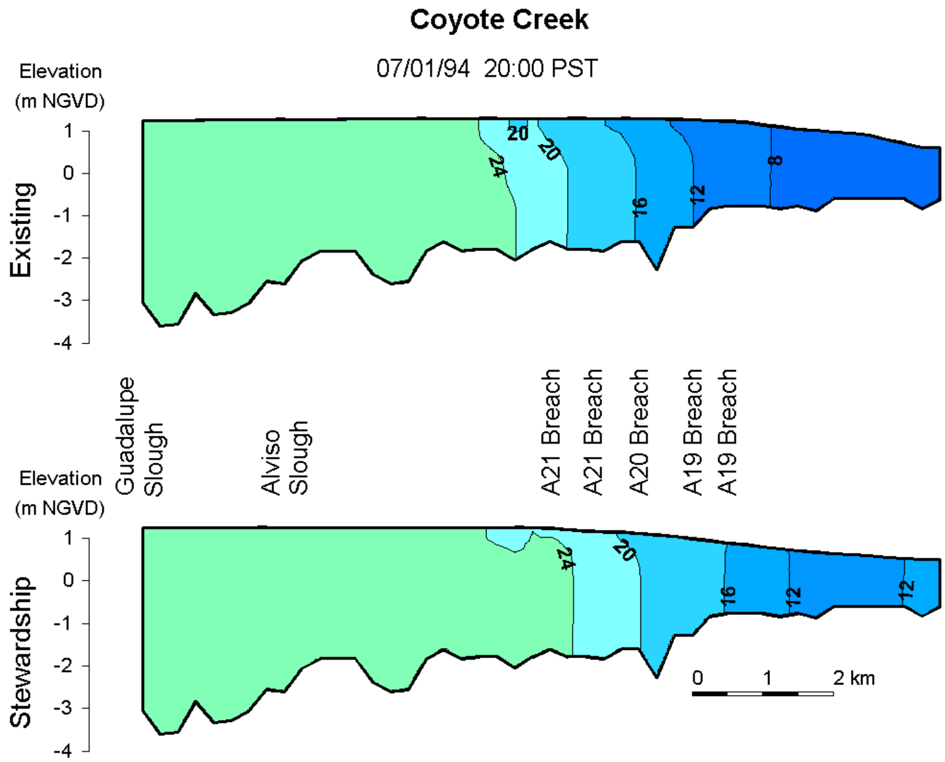
Note: Salinity map of Alviso Region indicates predicted depth-averaged and daily averaged salinity in each grid cell of the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.1-7 Predicted Alviso Region Salinity Comparison - Existing Conditions and Long Term Breach Scenario on July 21



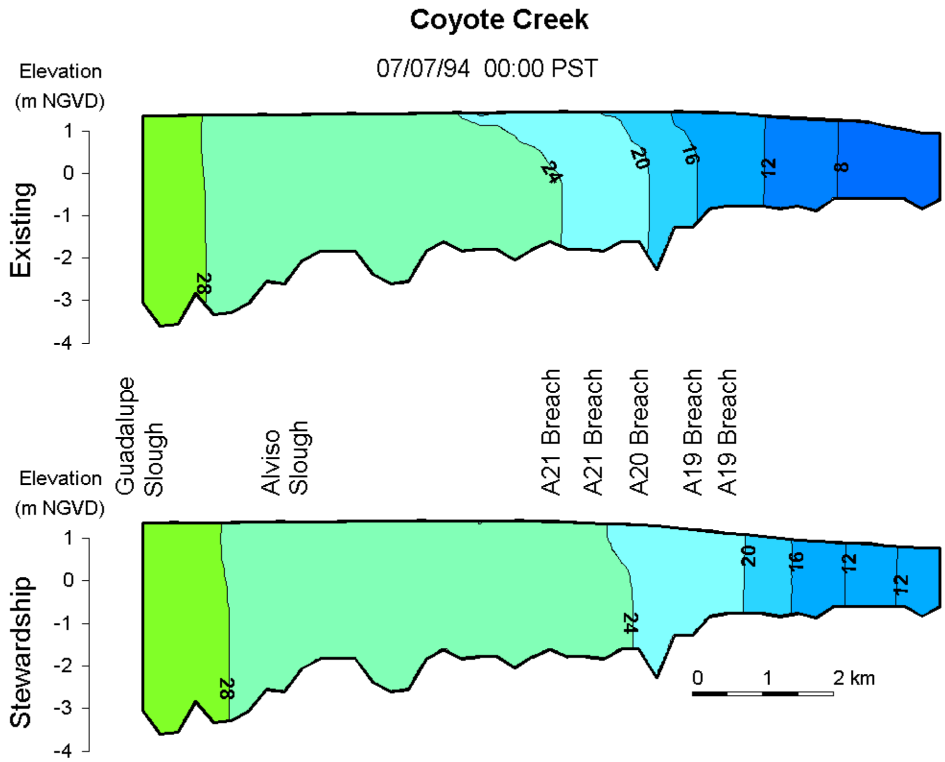
Note: Salinity map of Alviso Region indicates predicted depth-averaged and daily averaged salinity in each grid cell of the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.1-8 Predicted Alviso Region Salinity Comparison - Existing Conditions and Long Term Breach Scenario on July 28



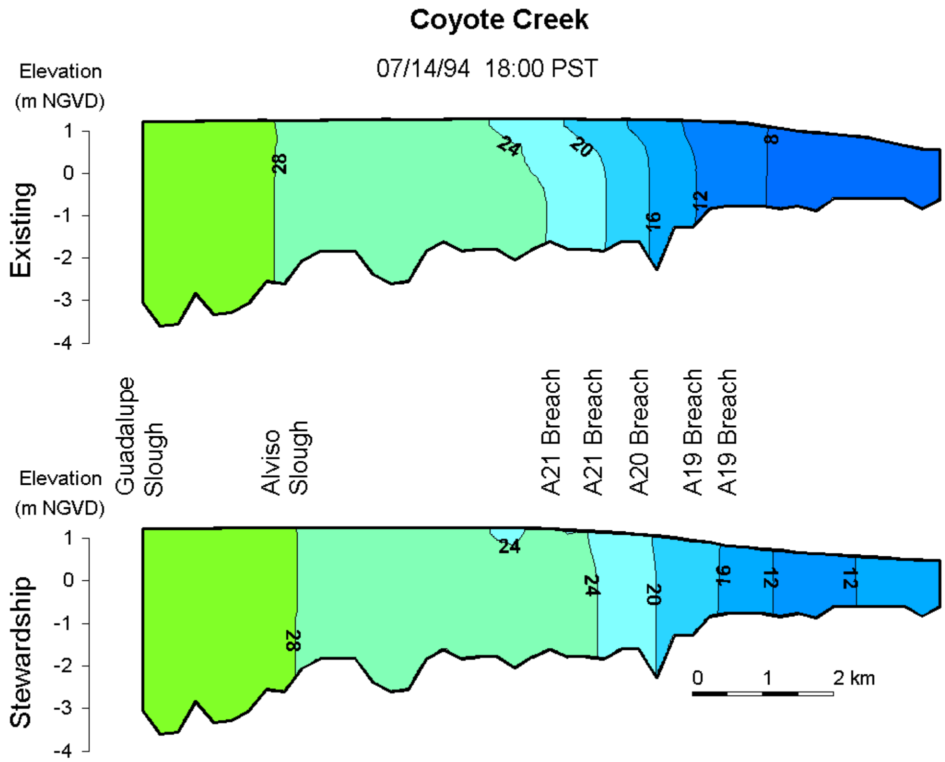
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.1-9 Predicted Coyote Creek Salinity Comparison - Existing Conditions and Long Term Breach Scenario on July 1



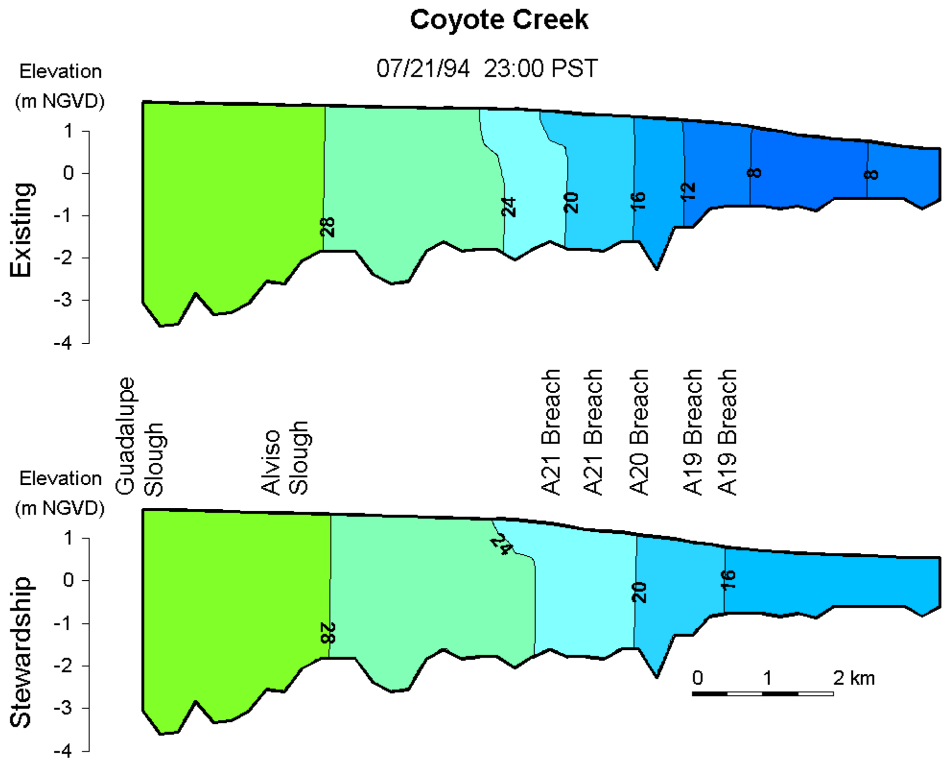
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.1-10 Predicted Coyote Creek Salinity Comparison - Existing Conditions and Long Term Breach Scenario on July 7



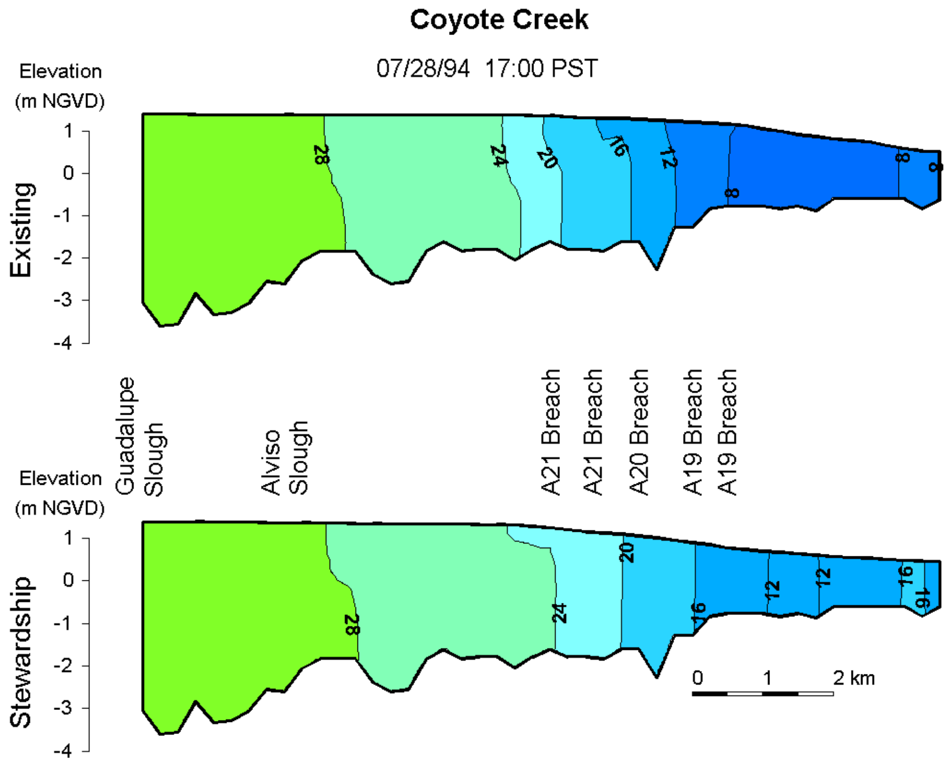
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model. Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.1-11 Predicted Coyote Creek Salinity Comparison - Existing Conditions and Long Term Breach Scenario on July 14



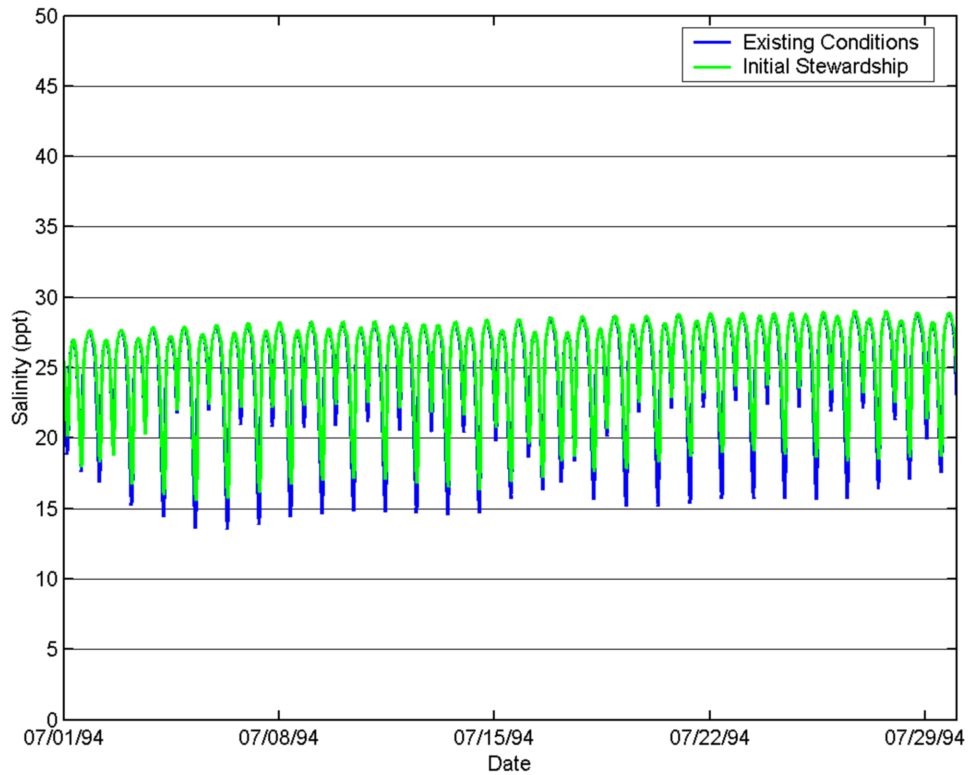
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.1-12 Predicted Coyote Creek Salinity Comparison - Existing Conditions and Long Term Breach Scenario on July 21



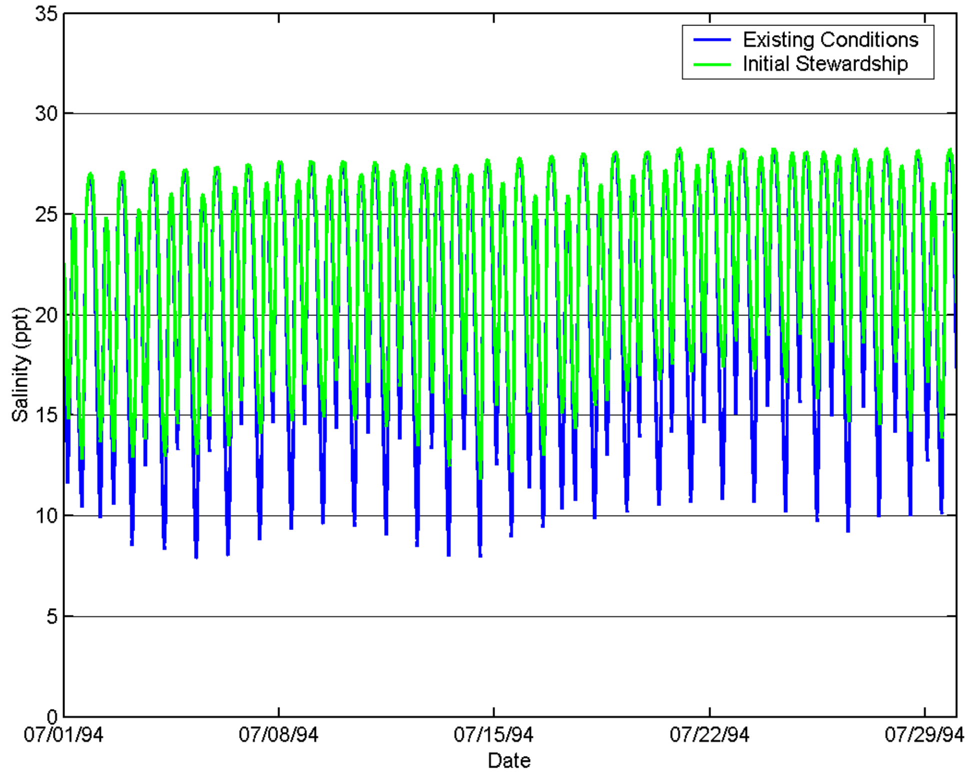
Note: Salinity profile computed along a longitudinal transect in the hydrodynamic model.
Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.1-13 Predicted Coyote Creek Salinity Comparison - Existing Conditions and Long Term Breach Scenario on July 28



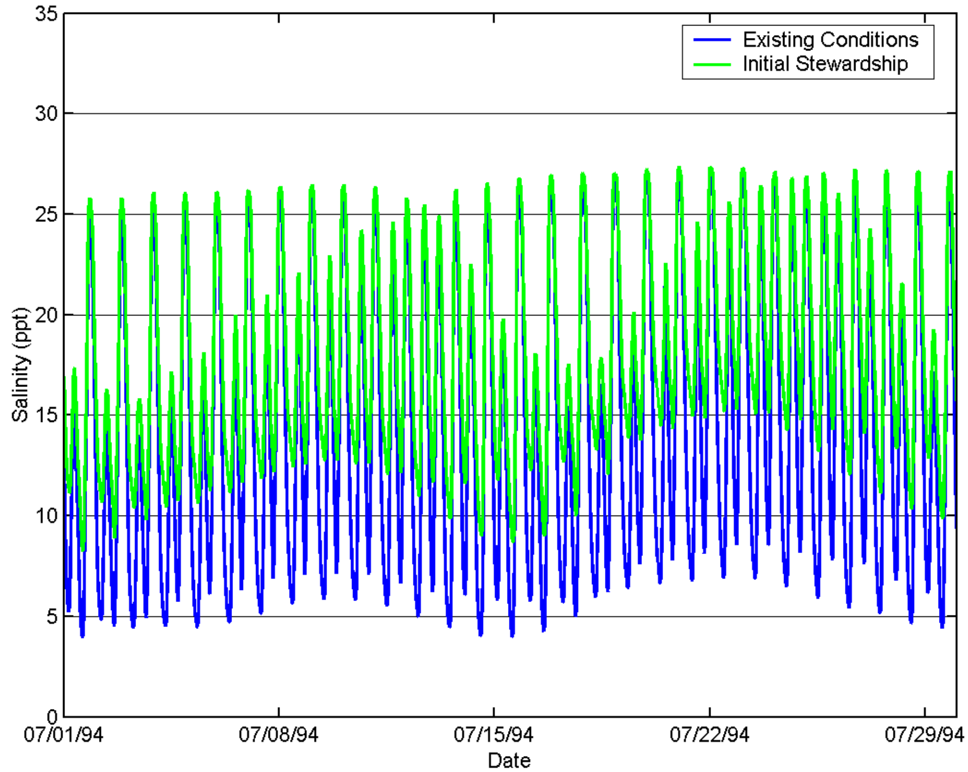
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.1-14 Predicted Coyote Creek 1 km Station Salinity – Existing Conditions and Long Term Breach Scenario for July



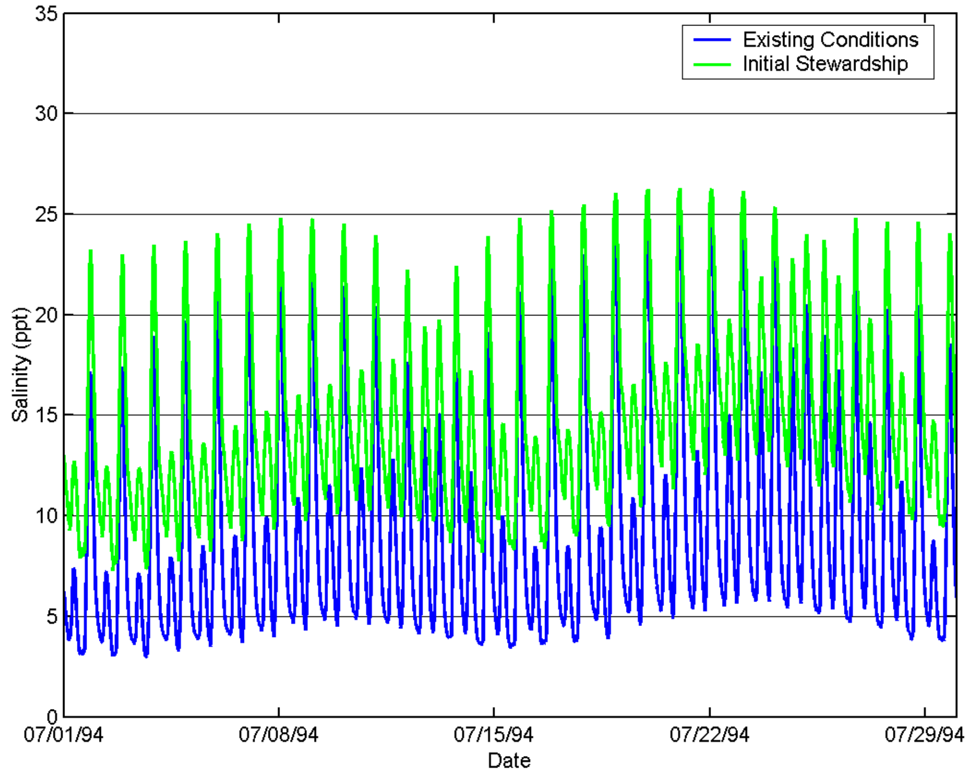
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.1-15 Predicted Coyote Creek 3 km Station Salinity – Existing Conditions and Long Term Breach Scenario for July



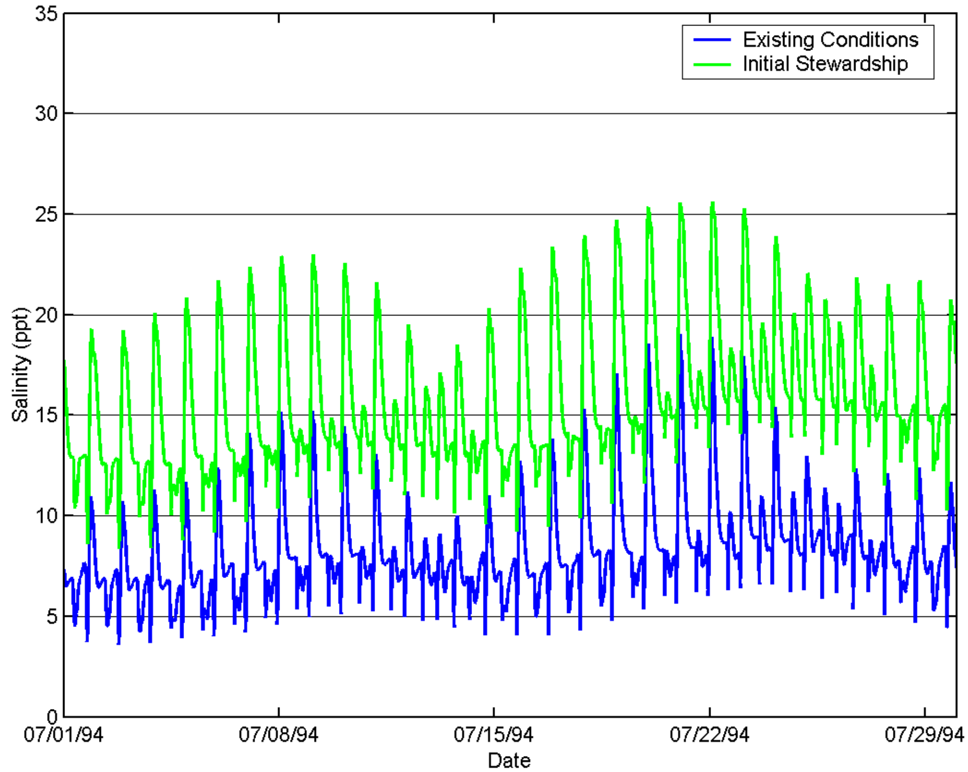
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.1-16 Predicted Coyote Creek 5 km Station Salinity – Existing Conditions and Long Term Breach Scenario for July



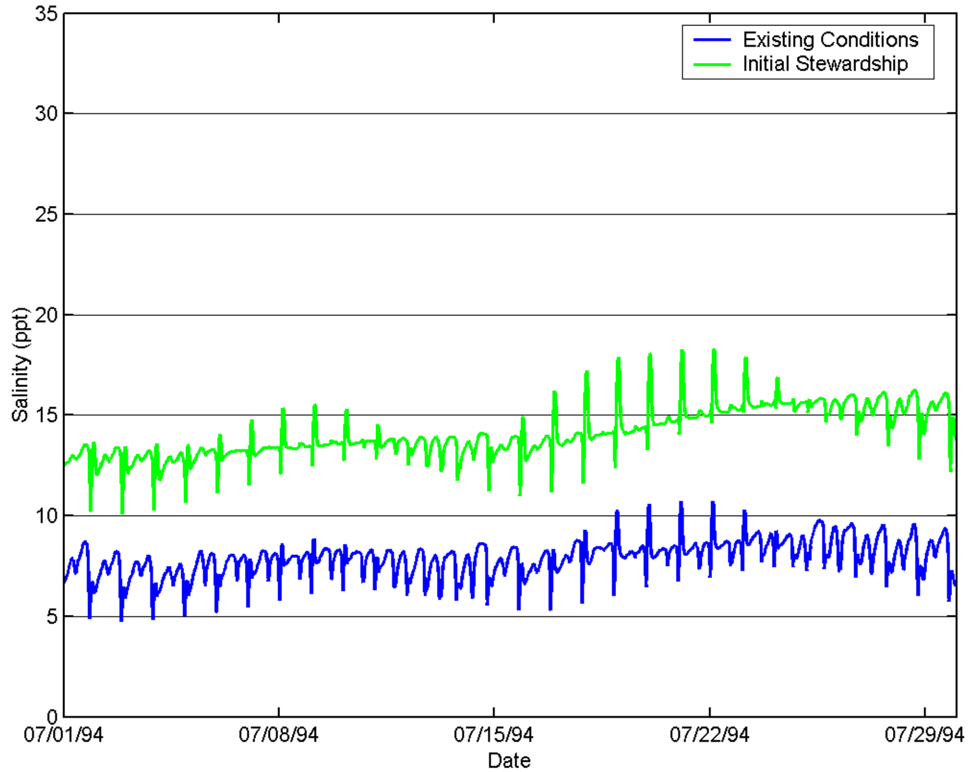
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.1-17 Predicted Coyote Creek 7 km Station Salinity – Existing Conditions and Long Term Breach Scenario for July



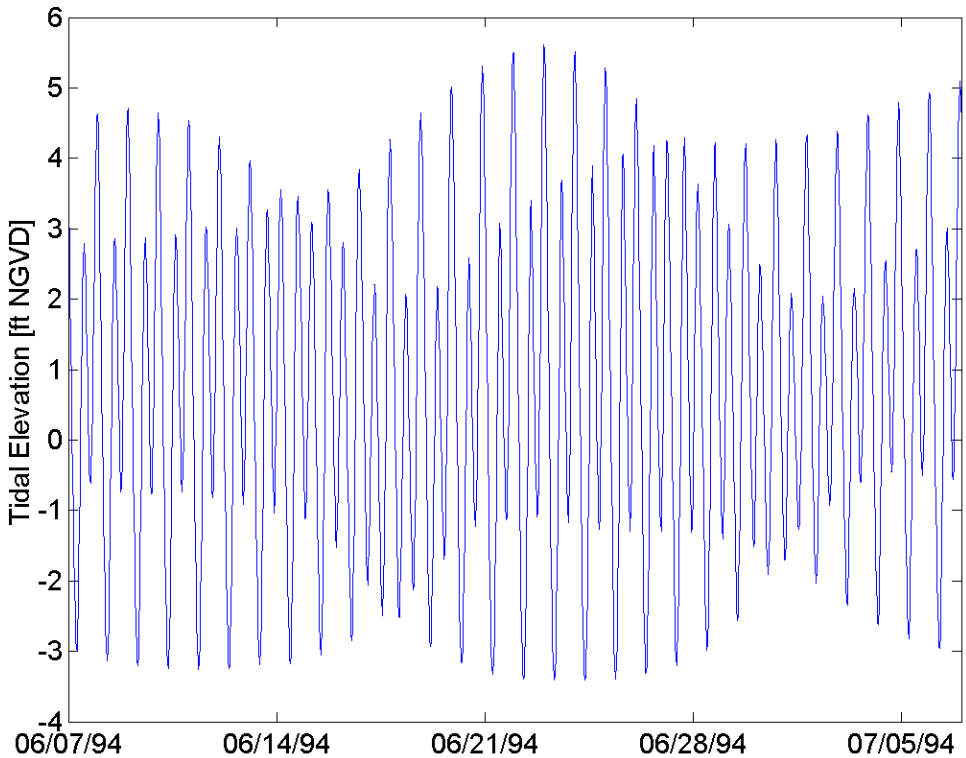
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.1-18 Predicted Coyote Creek 9 km Station Salinity – Existing Conditions and Long Term Breach Scenario for July



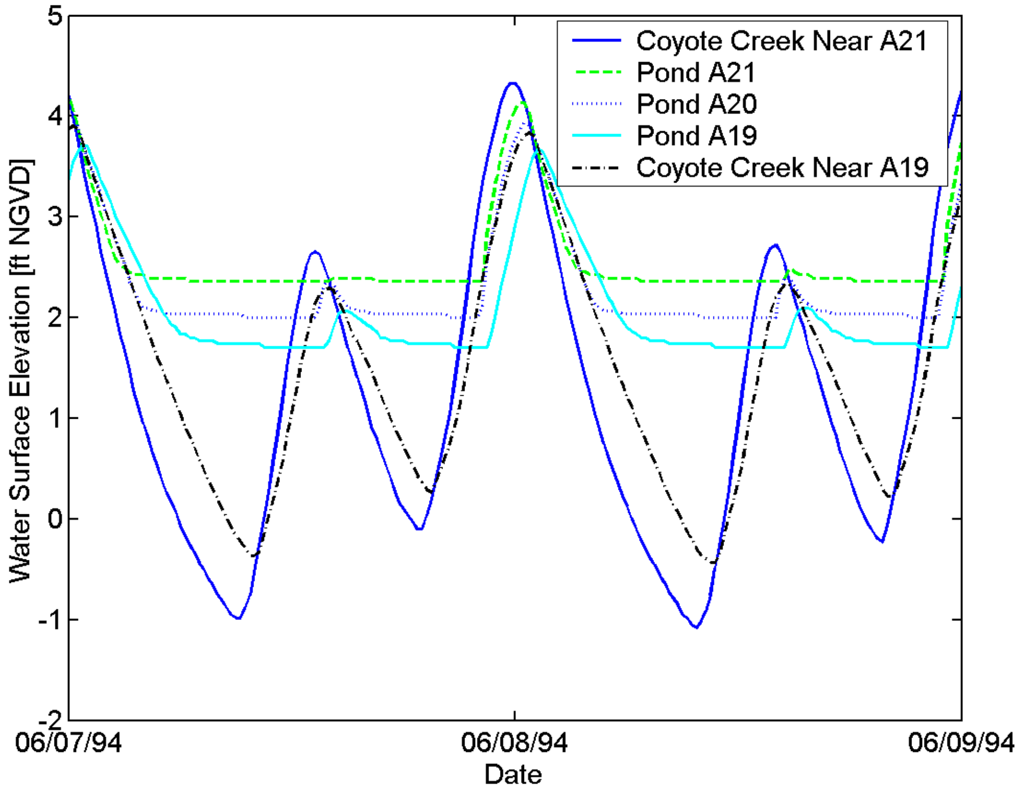
Note: Depth-averaged salinity predicted at the center of the channel. Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.1-19 Predicted Coyote Creek 11 km Station Salinity – Existing Conditions and Long Term Breach Scenario for July



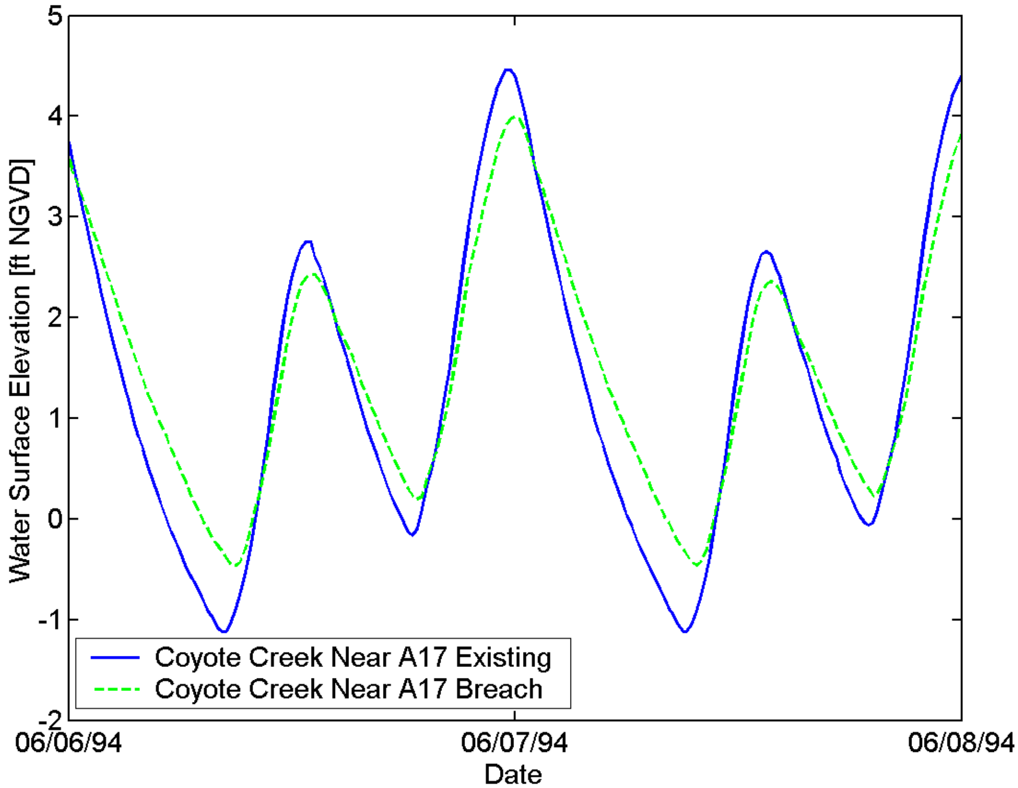
Note: Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.2-1 Tidal Elevation at Calaveras Point for 6/7/1994 through 7/7/1994



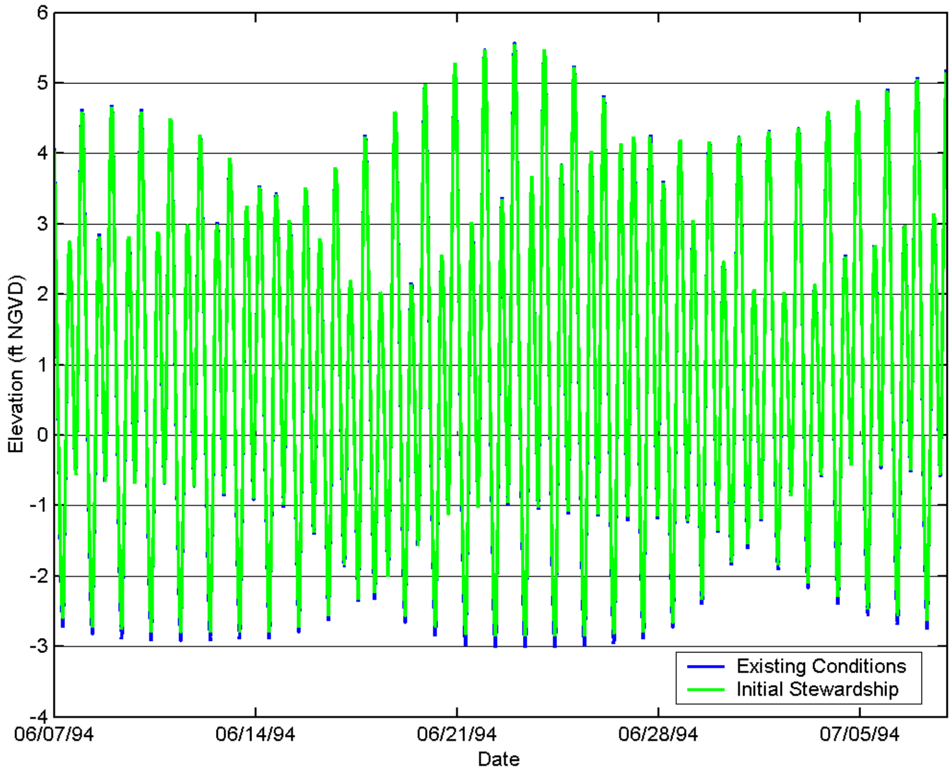
Note: Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.2.1-1 Water Surface Elevations (ft NGVD) for the Three Island Ponds and Coyote Creek for 6/7/94 through 6/9/94 under the Long Term Breach Scenario



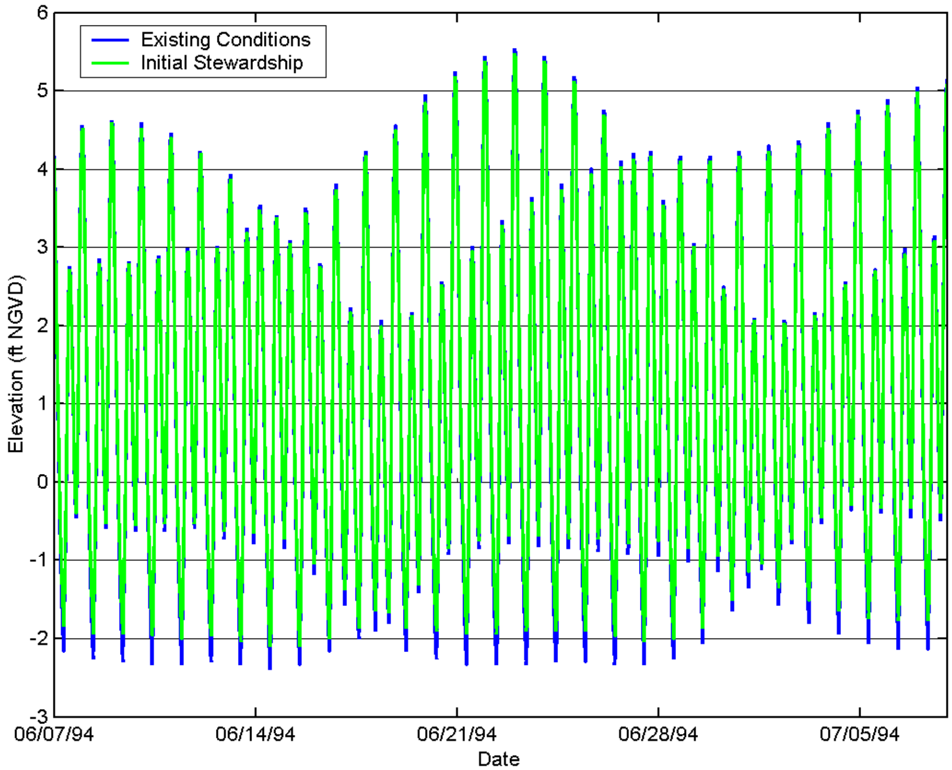
Note: Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.2.1-2 Water Surface Elevation in Coyote Creek near A17 for Existing Conditions and Long Term Breach scenarios



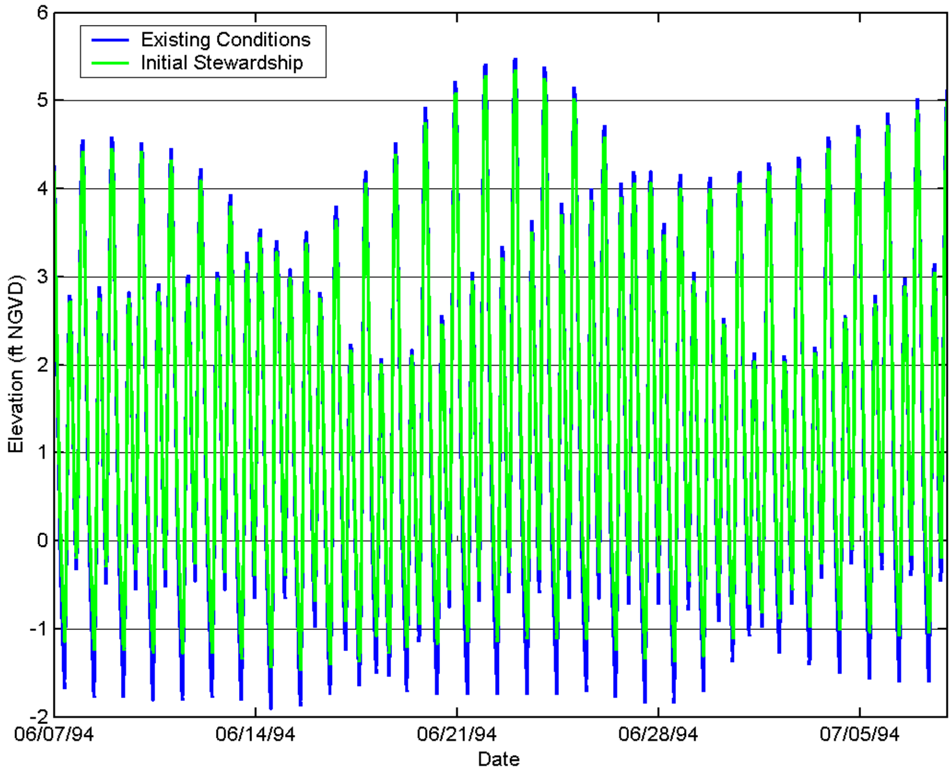
Note: Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.2.1-3 Predicted Tidal Elevation 1 km from the Mouth of Coyote Creek for June 7, 1994 through July 7, 1994 for Existing Conditions and the Long Term Breach Scenario



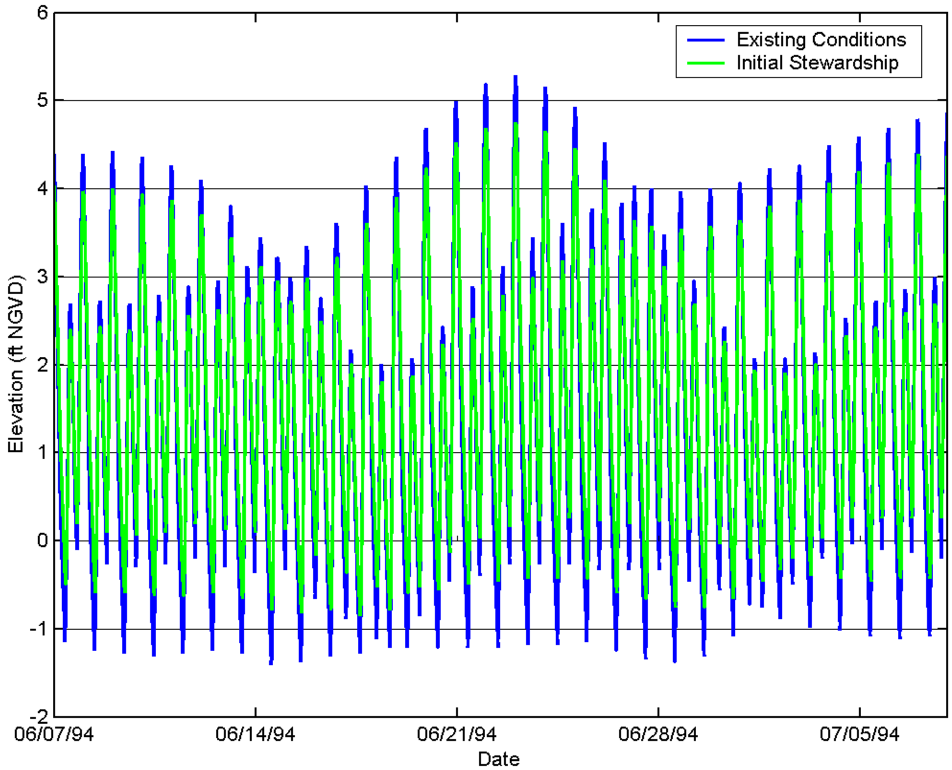
Note: Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.2.1-4 Predicted Tidal Elevation 3 km from the Mouth of Coyote Creek for June 7, 1994 through July 7, 1994 for Existing Conditions and the Long Term Breach Scenario



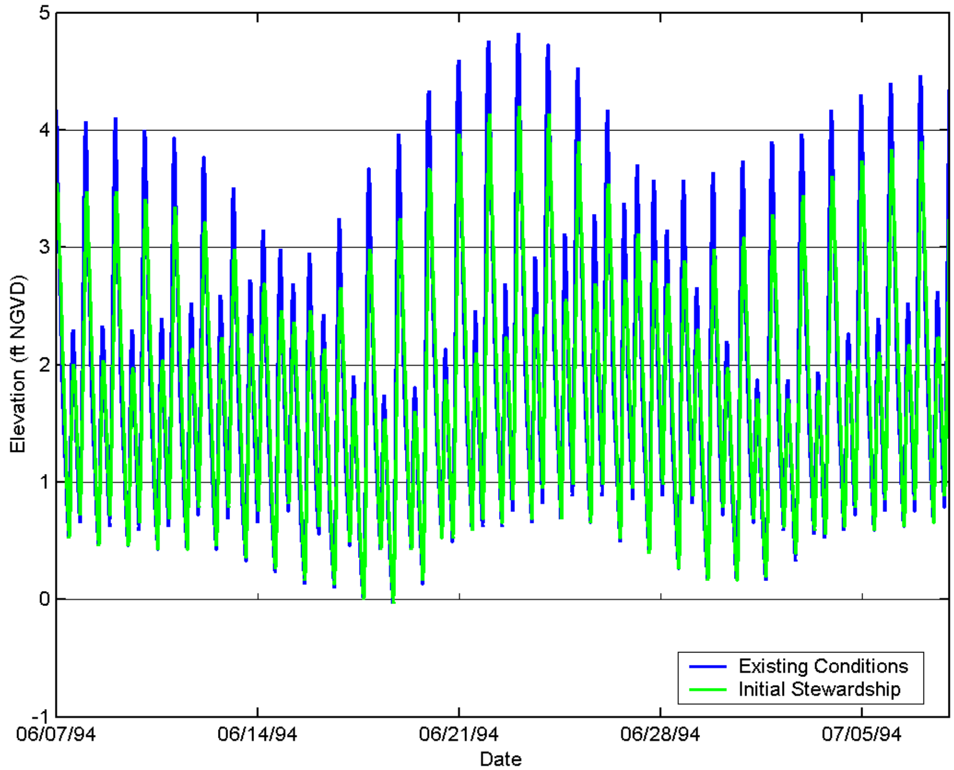
Note: Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.2.1-5 Predicted Tidal Elevation 5 km from the Mouth of Coyote Creek for June 7, 1994 through July 7, 1994 for Existing Conditions and the Long Term Breach Scenario



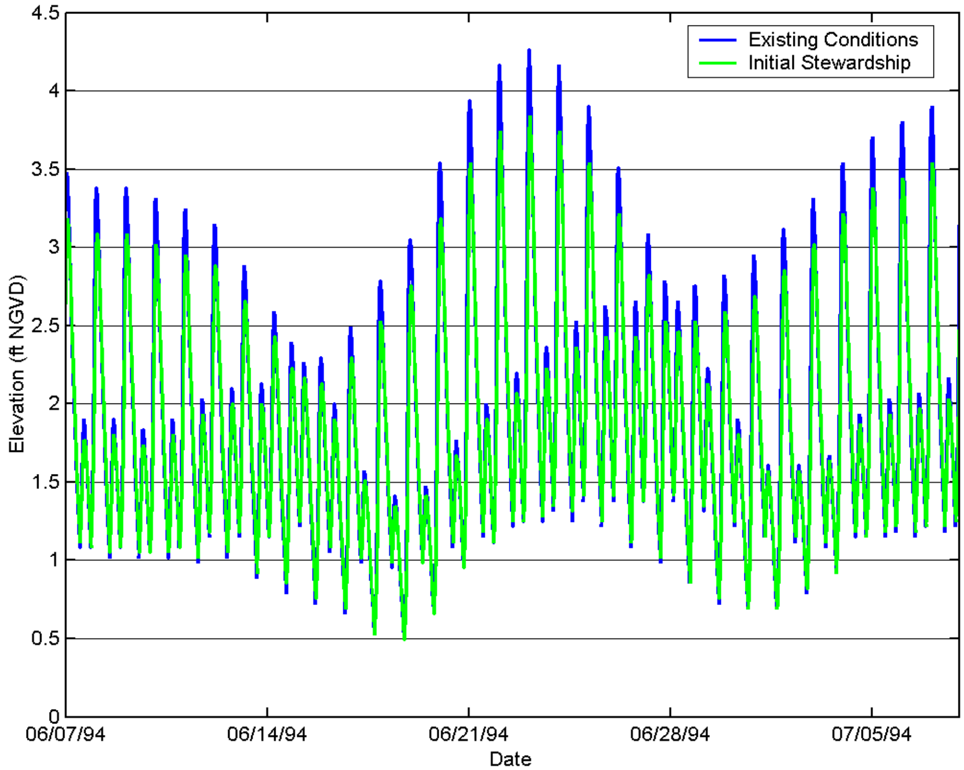
Note: Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.2.1-6 Predicted Tidal Elevation 7 km from the Mouth of Coyote Creek for June 7, 1994 through July 7, 1994 for Existing Conditions and the Long Term Breach Scenario



Note: Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.2.1-7 Predicted Tidal Elevation 9 km from the Mouth of Coyote Creek for June 7, 1994 through July 7, 1994 for Existing Conditions and the Long Term Breach Scenario



Note: Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.2.1-8 Predicted Tidal Elevation 11 km from the Mouth of Coyote Creek for June 7, 1994 through July 7, 1994 for Existing Conditions and the Long Term Breach Scenario

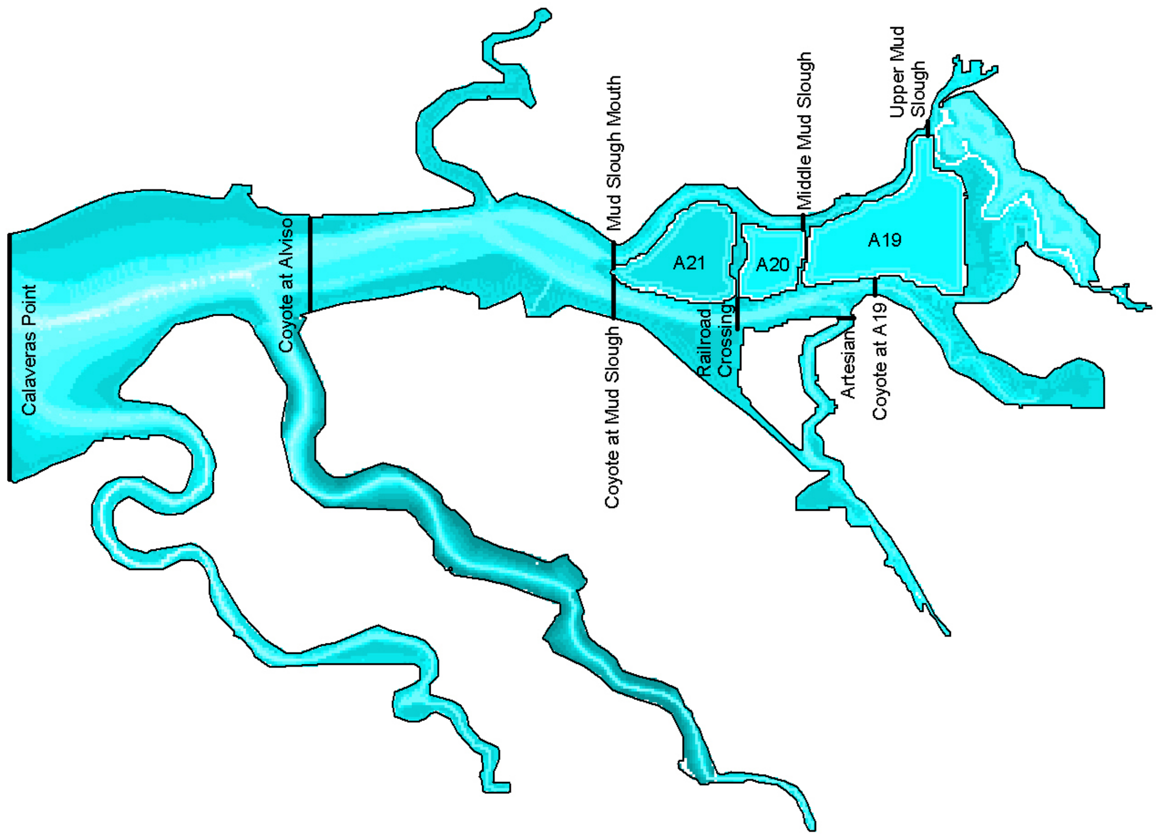
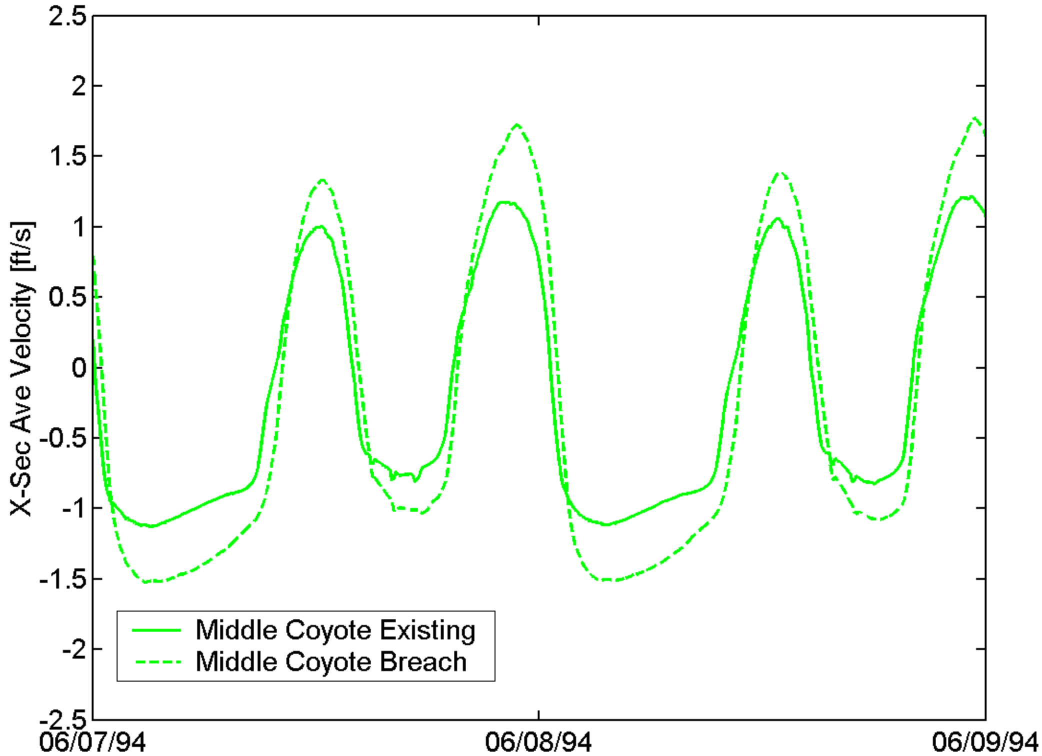
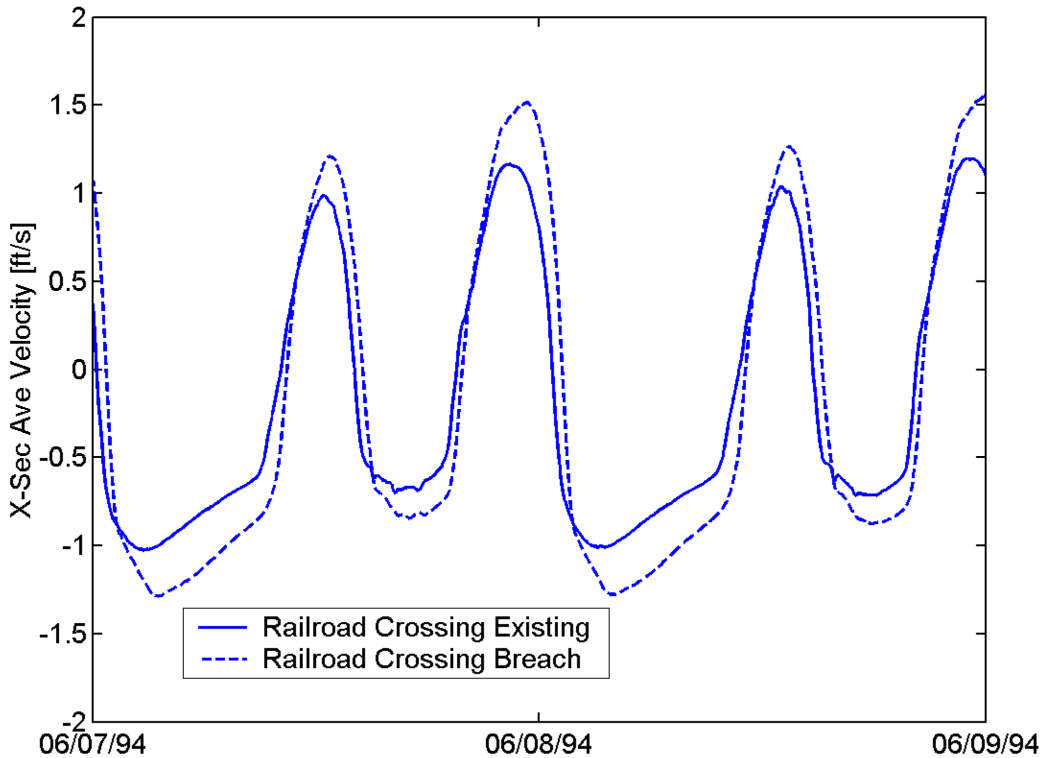


Figure 6.2.2-1 Location of Cross-sections for Tidal Prism Analysis



Note: Predicted based on 1994-1995 weather and tidal conditions.

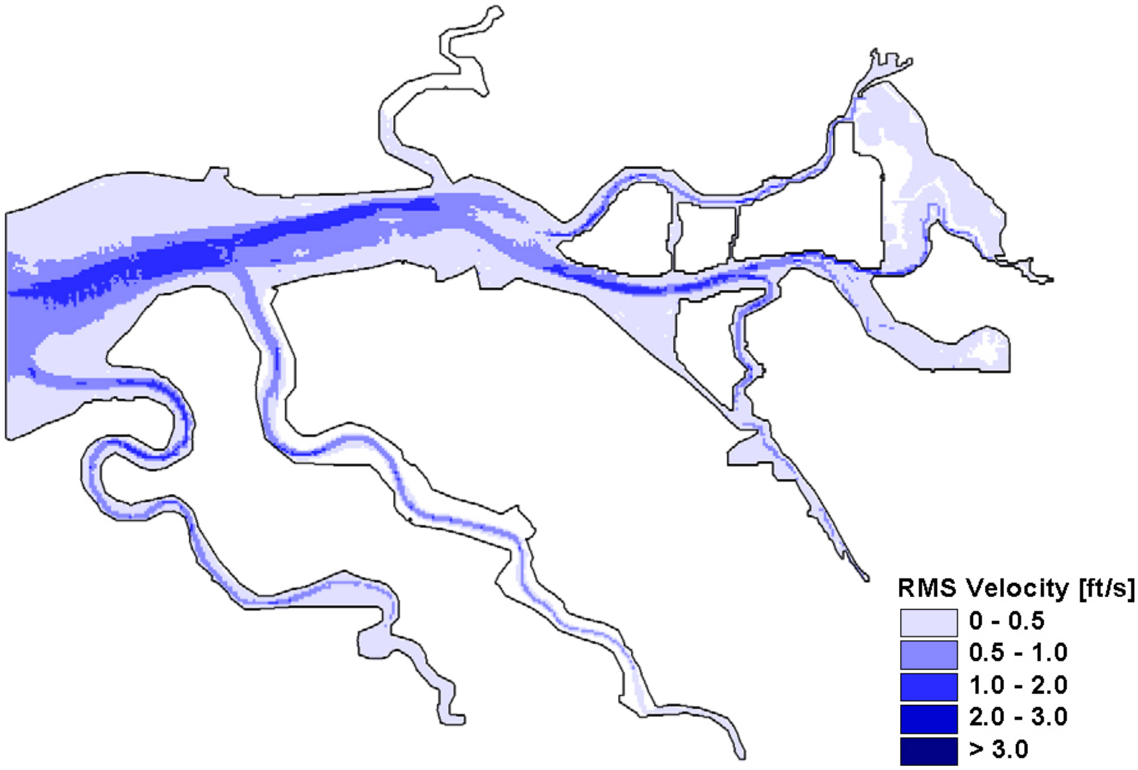
Figure 6.2.3-1 Cross-sectional Average Velocity for Coyote at Mud Slough Cross-section for 6/7/94 through 6/9/94



Note: Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.2.3-2 Cross-sectional Average Velocity for Railroad Crossing Cross-section for 6/7/94 through 6/9/94

Existing Conditions



Long Term Breach Scenario

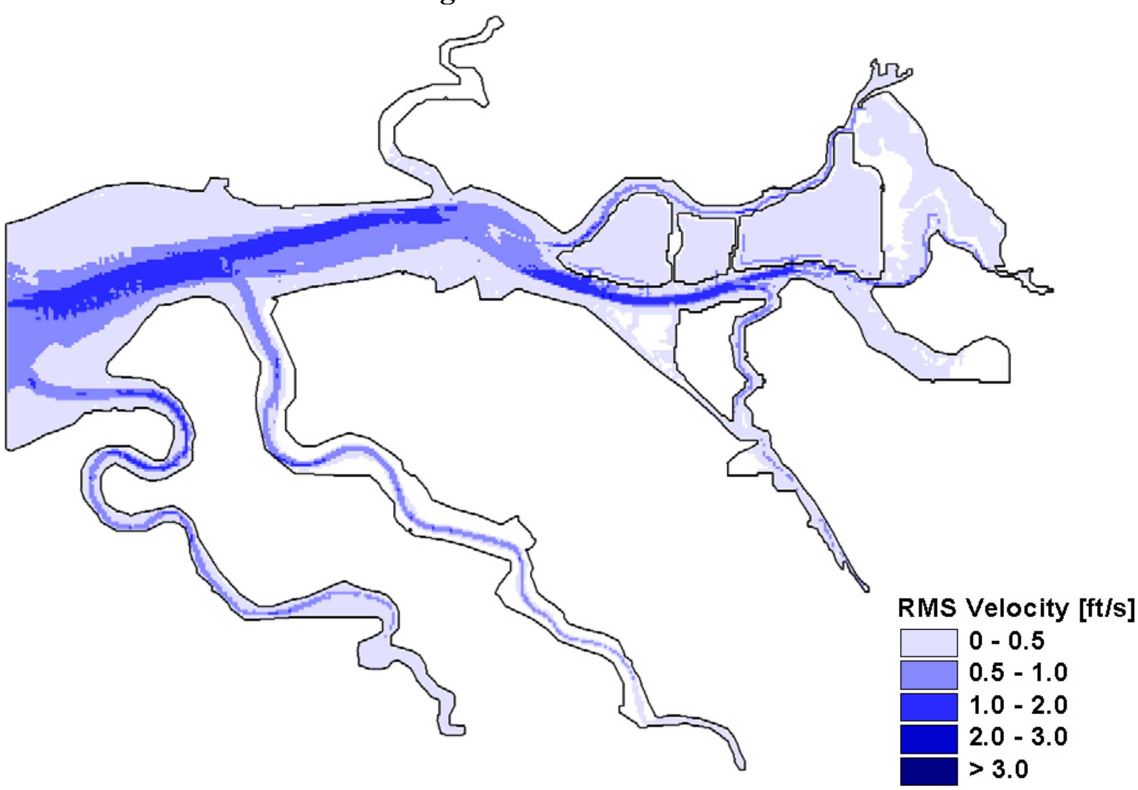
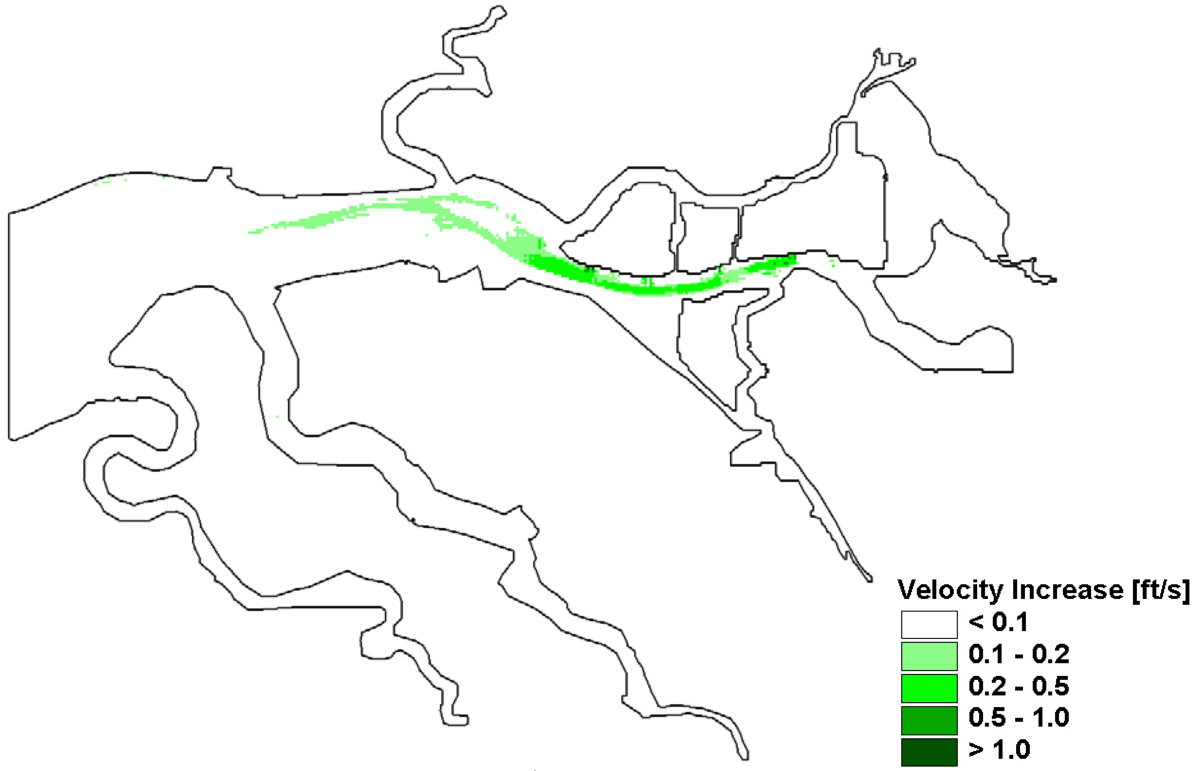


Figure 6.2.3-3 RMS Velocity for Existing Conditions and the Long Term Breach Scenario

Velocity Increases



Velocity Decreases

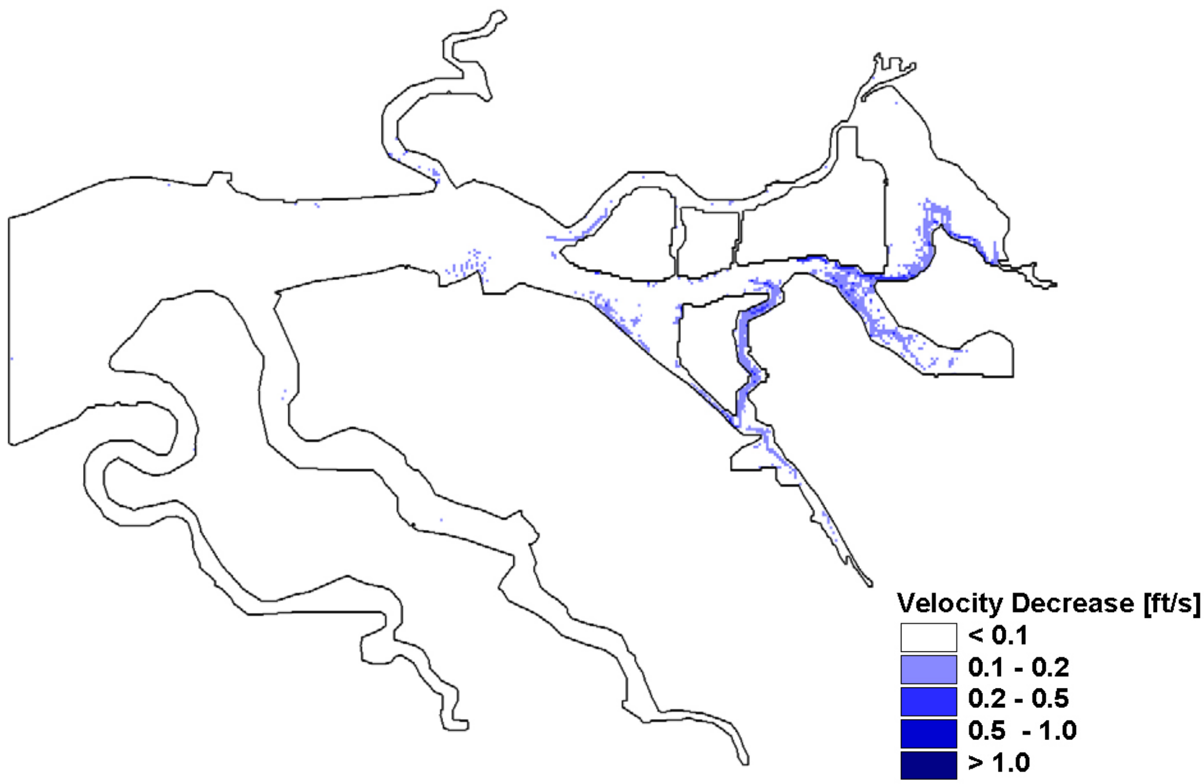
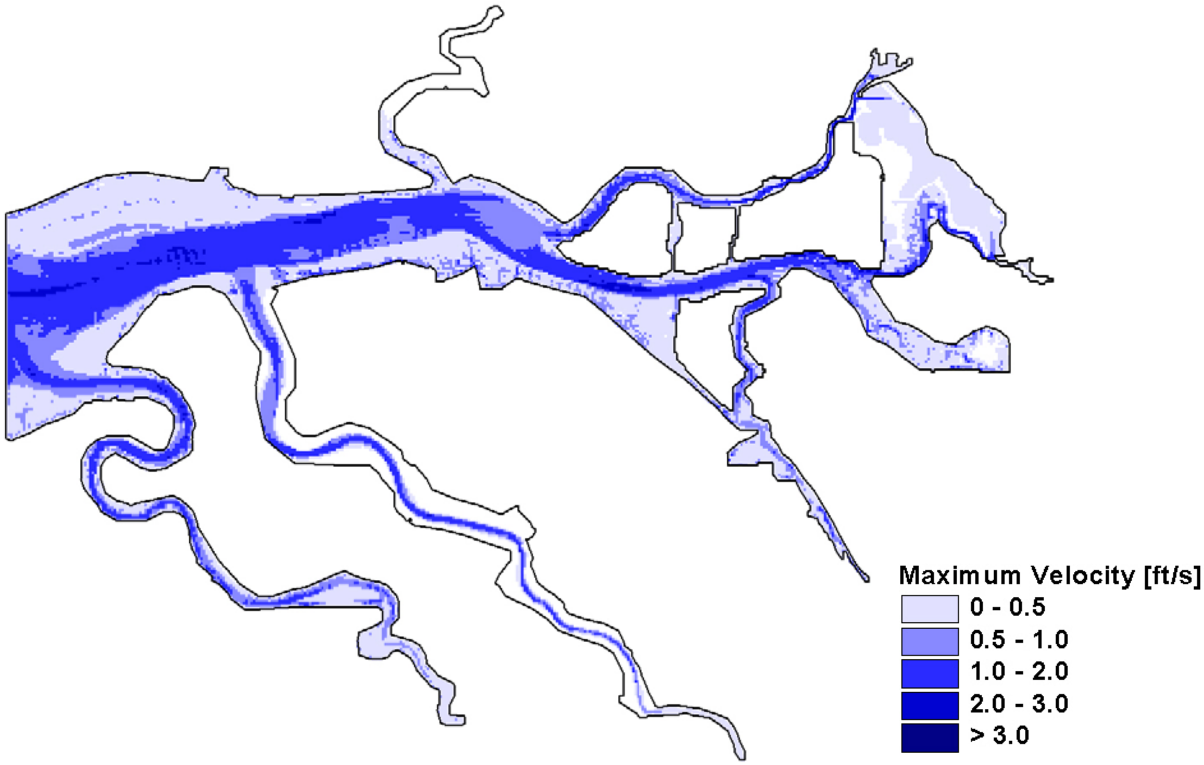


Figure 6.2.3-4 Increases and Decreases in RMS Velocity Resulting from Levee Breaches

Existing Conditions



Long Term Breach Scenario

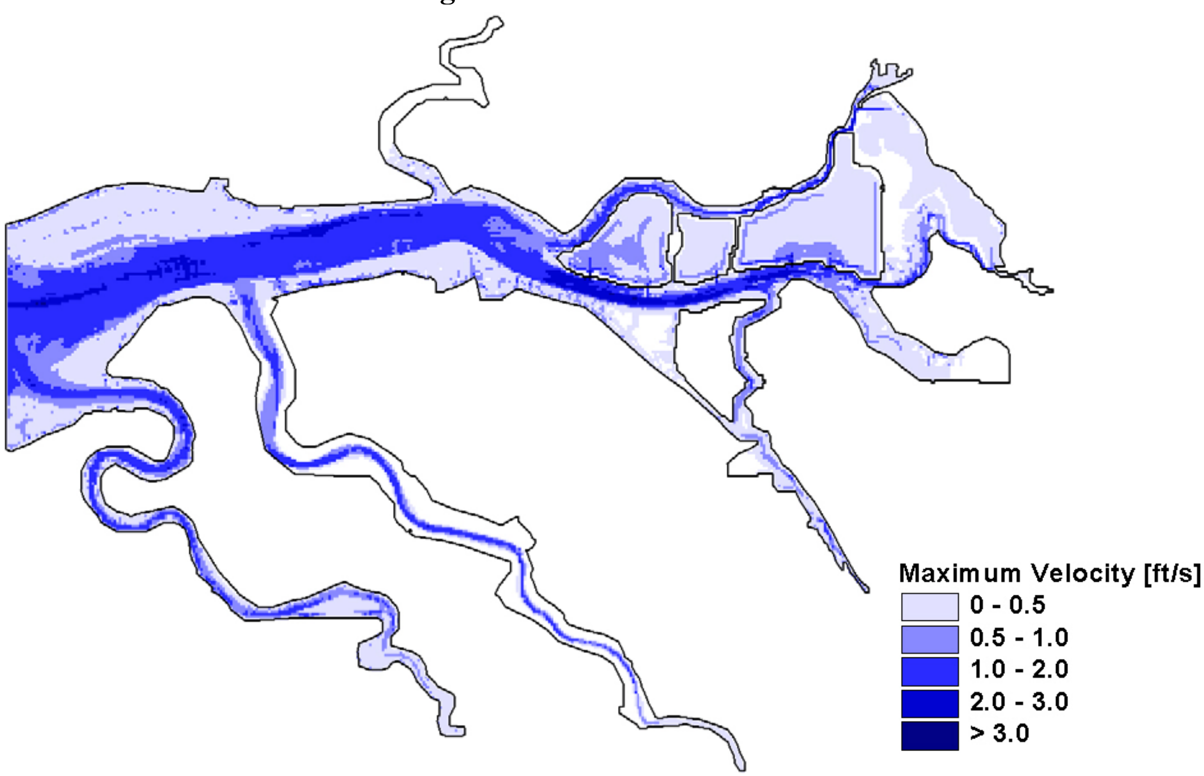
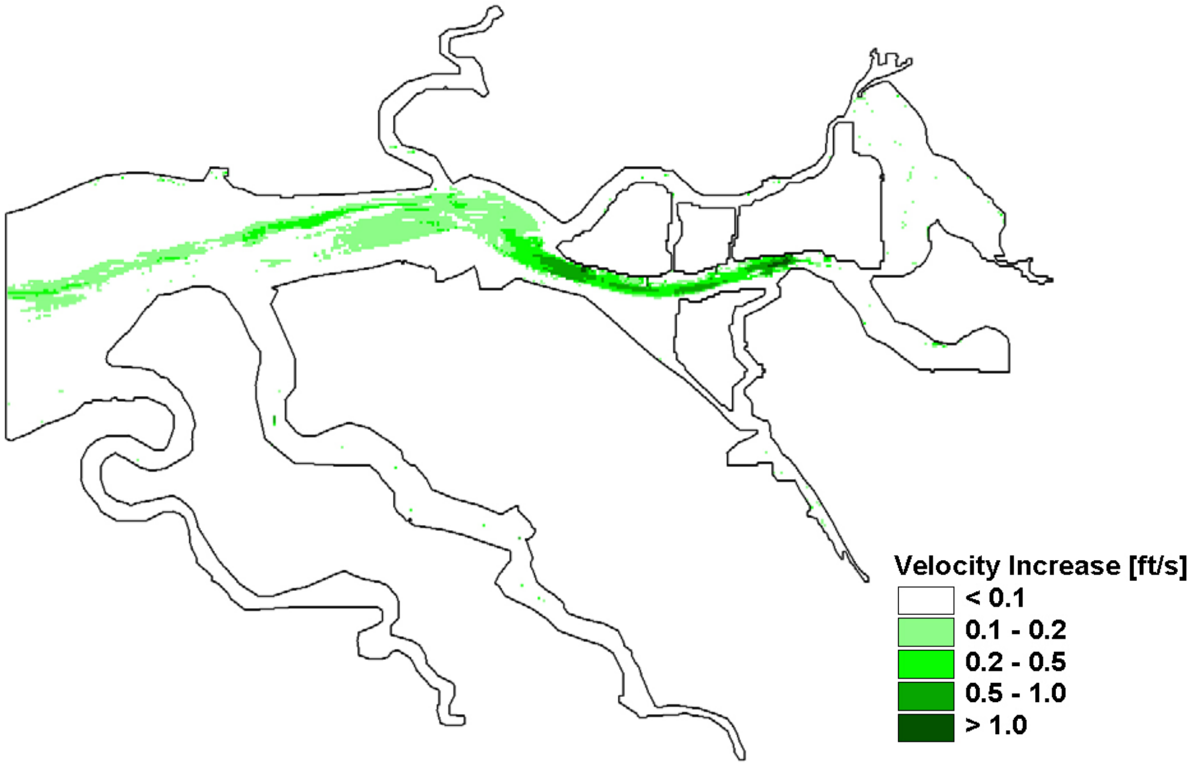


Figure 6.2.3-5 Maximum Velocity for Existing Conditions and the Long Term Breach Scenario

Velocity Increases



Velocity Decreases

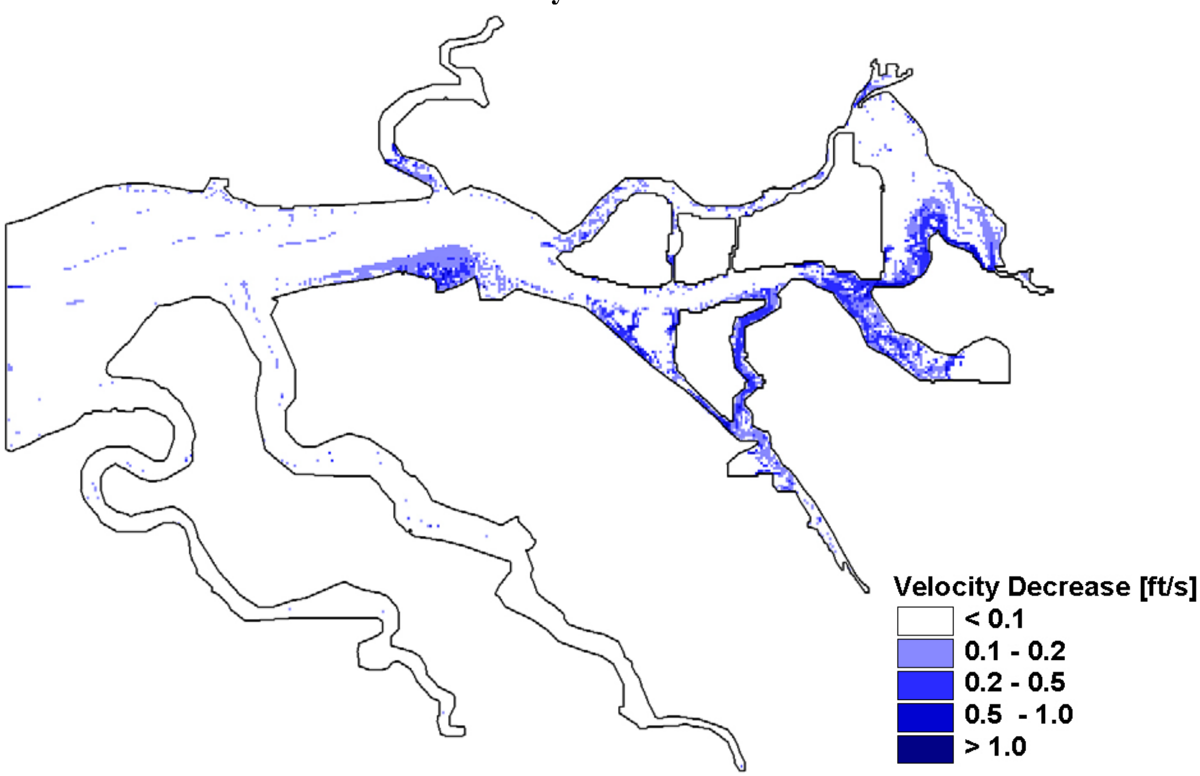
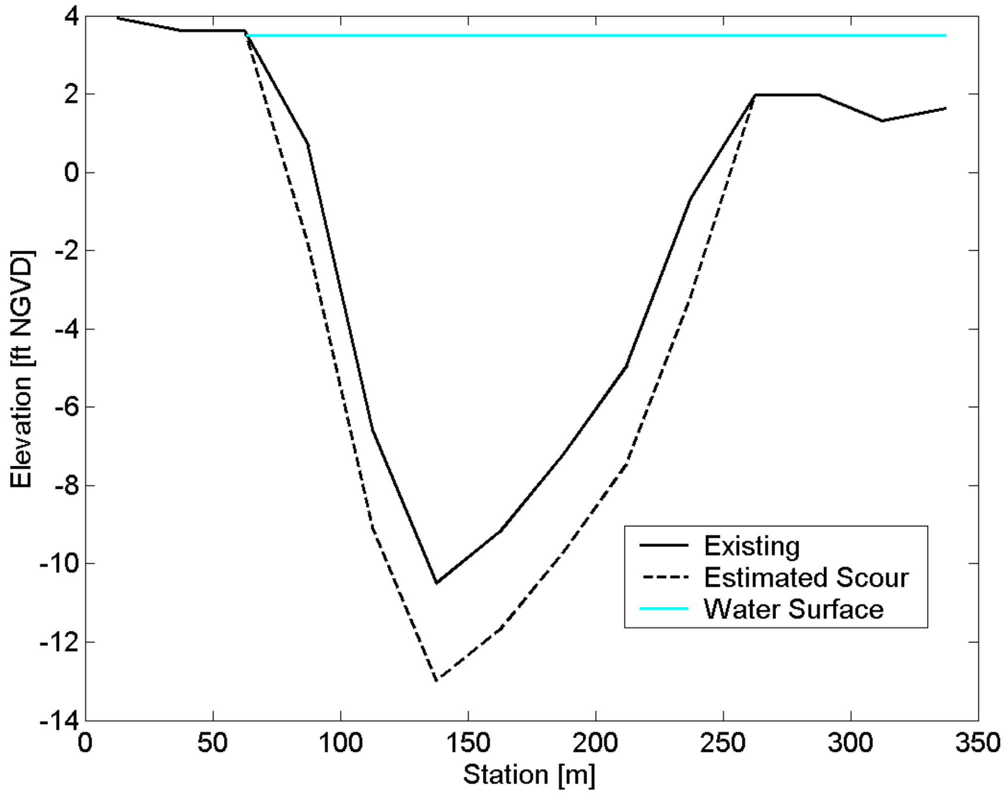
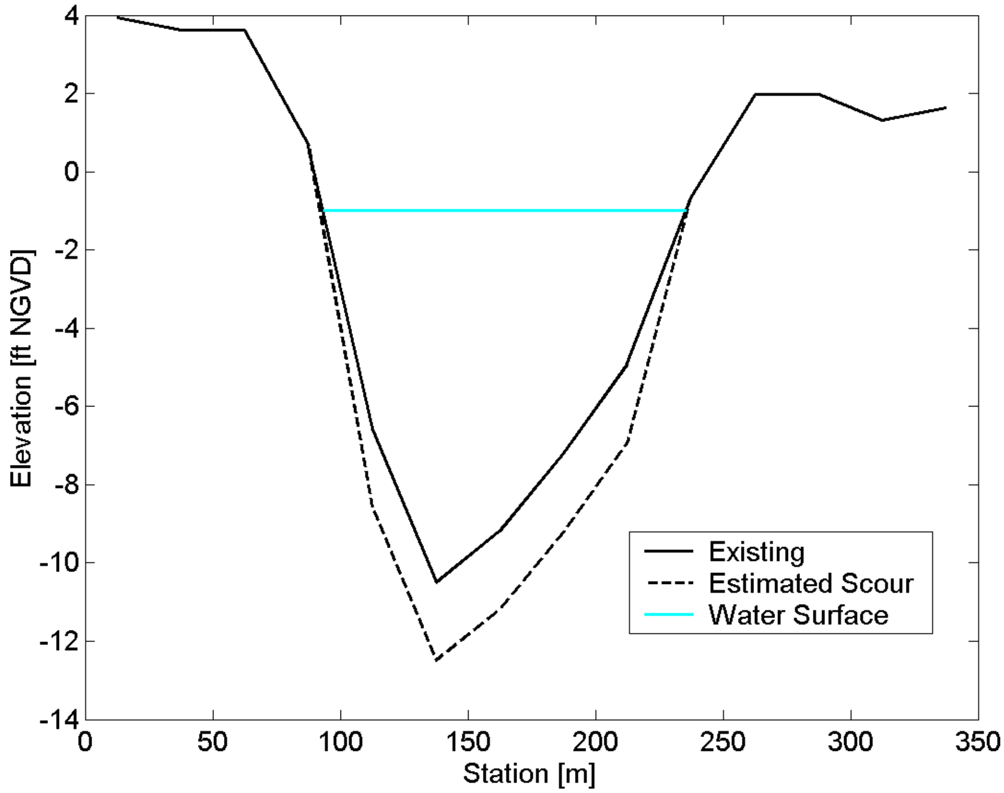


Figure 6.2.3-6 Increases and Decreases in Maximum Velocity Resulting from Levee Breaches



Note: Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.2.5-1 Existing Cross-Section Geometry and the Estimated Scour at Railroad Crossing Cross-Section for the Peak Flood Tide Velocity



Note: Predicted based on 1994-1995 weather and tidal conditions.

Figure 6.2.5-2 Existing Cross-Section Geometry and the Estimated Scour at Railroad Crossing Cross-Section for the Peak Ebb Tide Velocity

APPENDIX L

Species Composition of Fish, Shrimp, and Crabs Collected by the California Department of Fish and Game Fishery Surveys from South Bay

Introduction

California Department of Fish and Game (Baxter *et al.* 1999; CDFGF unpublished) has conducted an extensive fishery survey within the Bay-Delta estuary, which began in 1980 and continues to date. The fishery survey program designed and implemented by CDFG (Baxter *et al.* 1999) is a long-term study with data collected monthly, primarily in deeper sub-tidal areas, using multiple gear types including the otter trawl, mid-water trawl, beach seine and plankton nets. This survey is useful as a long-term record on the regional occurrence of various species within the area and intra- and inter-annual variability in their abundance.

The objective of this write-up is to summarize and analyze information from CDF & G surveys to characterize: species composition, differences by location/habitat, and occurrence of threatened and endangered species.

CDF & G 1980-2001 Surveys

Survey design

Fishery samples have been collected by CDF &G at approximately monthly intervals, using mid-water trawls and otter trawls, from 35 stations from the South Bay and upstream in the Sacramento River to Sherman Island and the San Joaquin River at Antioch (Figure 1). An additional 17 sampling stations were added between 1988 and 1994. The frequency of sampling between 1980 and 2001 (Baxter *et al.* 1999) is shown in Figure 2.

Based on the types of trawls and data available, CDF & G sampling stations were chosen for analysis that would reflect the conditions of the South Bay that may be affected by the proposed project. Three open water stations, with data collected by otter and mid-water trawls and plankton nets, are in the vicinity of Alviso and Baumberg Unit Ponds: Stations 101, 102 and 140 (Figure 3). Two beach seine stations in the general vicinity of the pond units are Station 171 and 172. Further information regarding the fishery surveys, analysis of species composition, and maps showing sampling sites are presented by Baxter *et al.* (1999) and briefly summarized below.

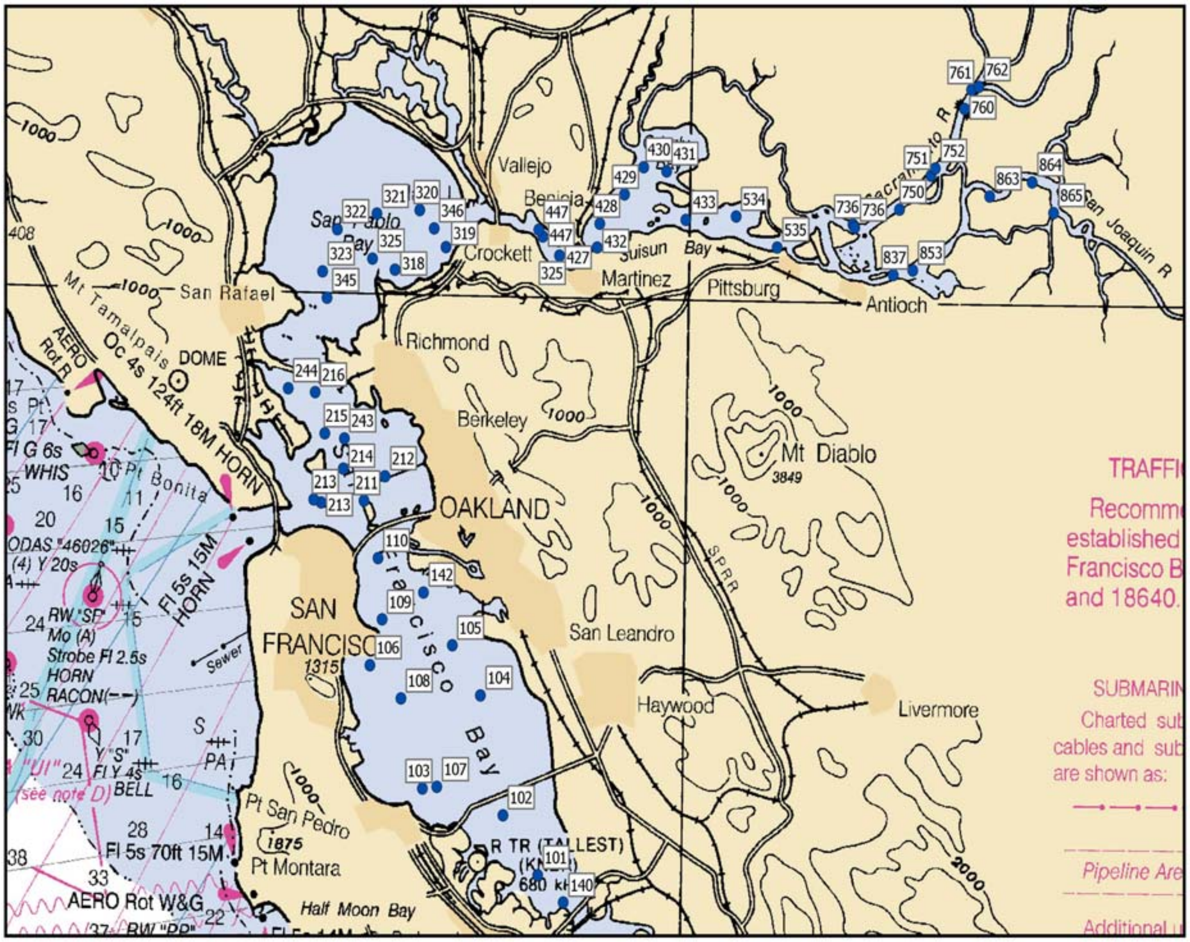
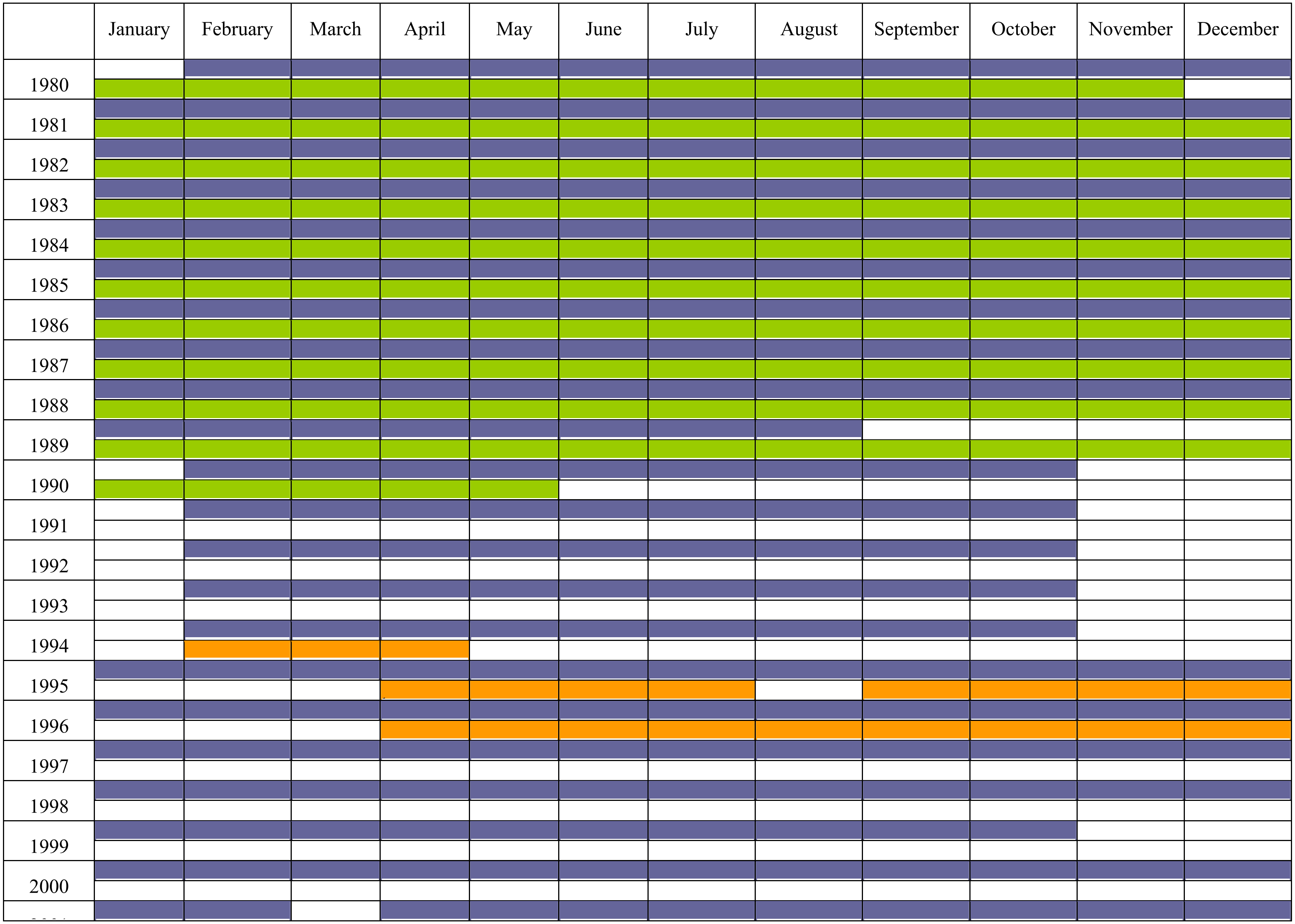


Figure 1. CDFG open water stations (Baxter *et al*. 1999) within the Bay-Delta estuary.


January
February
March
April
May
June
July
August
September
October
November
December
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000

	January	February	March	April	May	June	July	August	September	October	November	December
	Plankton Net					a-Midwater trawl sampled only Feb. to April						
	Midwater and Otter Trawls					b-Midwater Trawl Sampled to April to Dec. except Aug (did not sample)						
	Only Midwater Trawl					c-Midwater trawl sampled April to Dec.						

Figure 2. Frequency of fishery sampling by CDF&G within the Bay-Delta estuary.

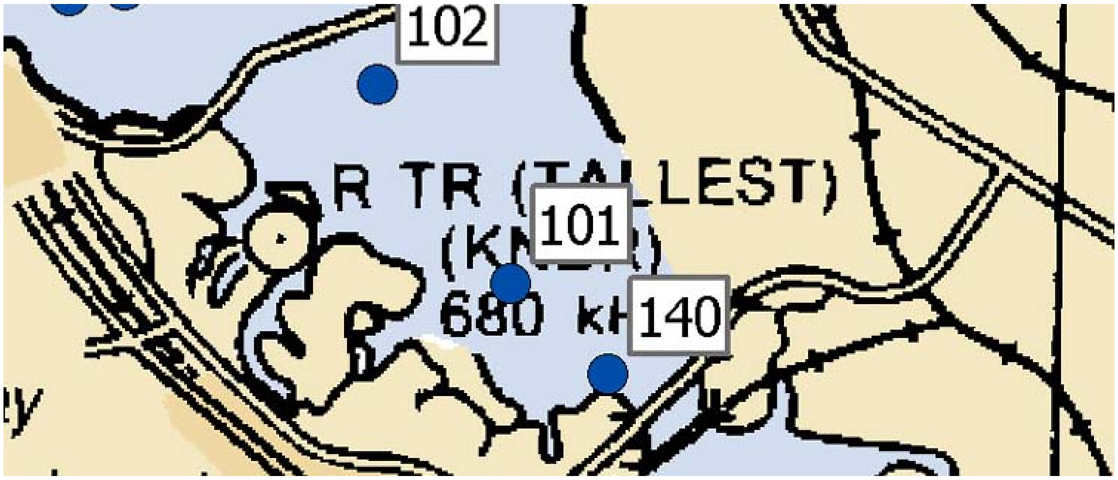


Figure 3: **Close Up of CDF&G open water stations (Baxter *et al*. 1999) within the South Bay in the general vicinity of the proposed project.**

Sampling Methods

Open water stations were sampled using otter trawls, mid-water trawls and plankton nets. The otter trawl was towed on the bottom against the current for 5 minutes and then retrieved. The mid-water trawl was towed with the current for 12 minutes and retrieved obliquely. The plankton net was towed for 5 minutes on the bottom, and retrieved obliquely.

Species Composition

Species composition of the fish community as well as the macroinvertebrate (crab and shrimp) community sampled in the vicinity of the proposed project were summarized and analyzed using the data from the 1980-2002 CDF & G surveys. crab and shrimp data were collected from 1980-2001. Species composition is determined as a percentage of the catch of each individual species divided by the total catch of all species for each group of surveyed stations. Results of the fishery surveys showing species composition, by sampling station and collection method are summarized in the following tables.

Otter Trawl

Station 101

Common Name	Percent Composition
northern anchovy	34.76%
shiner perch	19.23%
longfin smelt	13.86%
white croaker	9.75%
Pacific staghorn sculpin	4.46%
bay goby	4.34%
plainfin midshipman	3.06%
brown smoothhound	1.66%
English sole	1.25%
California tonguefish	1.13%
yellowfin goby	1.10%
leopard shark	1.01%
speckled sanddab	0.79%
cheekspot goby	0.59%
chameleon goby	0.44%
striped bass	0.37%
dwarf perch	0.35%
Pacific herring	0.35%
bat ray	0.15%
topsmelt	0.15%
showy snailfish	0.12%
starry flounder	0.12%
brown rockfish	0.10%
threadfin shad	0.10%
barred surfperch	0.08%
jacksmelt	0.08%
California halibut	0.07%
big skate	0.05%
bonehead sculpin	0.05%
Pacific lamprey	0.05%
pile perch	0.05%
silver surfperch	0.05%
white sturgeon	0.05%
arrow goby	0.03%
bay pipefish	0.03%
American shad	0.02%
diamond turbot	0.02%
longjaw mudsucker	0.02%

Common Name	Percent Composition
Pacific tomcod	0.02%
sand sole	0.02%
threespine stickleback	0.02%
white seaperch	0.02%

Otter Trawl

Station 102

Common Name	Percent Composition
northern anchovy	24.64%
bay goby	19.06%
shiner perch	17.05%
English sole	11.96%
cheekspot goby	5.72%
speckled sanddab	4.03%
Pacific herring	3.46%
white croaker	3.46%
Pacific staghorn sculpin	1.67%
chameleon goby	1.55%
California tonguefish	1.04%
longfin smelt	1.02%
plainfin midshipman	0.92%
dwarf perch	0.83%
brown smoothhound	0.57%
yellowfin goby	0.26%
barred surfperch	0.24%
starry flounder	0.24%
California halibut	0.22%
black perch	0.20%
diamond turbot	0.20%
bat ray	0.16%
threadfin shad	0.16%
Pacific lamprey	0.14%
walleye surfperch	0.14%
leopard shark	0.12%
arrow goby	0.10%
brown rockfish	0.10%
showy snailfish	0.10%
bay pipefish	0.08%
pile perch	0.08%
striped bass	0.08%
topsmelt	0.08%
white seaperch	0.06%
American shad	0.04%
unidentified rockfish	0.04%
white sturgeon	0.04%
big skate	0.02%

Common Name	Percent Composition
bonehead sculpin	0.02%
curlfin sole	0.02%
jacksmelt	0.02%
Pacific tomcod	0.02%
sand sole	0.02%
silver surfperch	0.02%
threespine stickleback	0.02%
whitebait smelt	0.02%

Otter Trawl

Station 140

Common Name	Percent Composition
shiner perch	34.72%
bay goby	8.32%
plainfin midshipman	7.85%
northern anchovy	7.67%
English sole	7.37%
Pacific staghorn sculpin	6.96%
white croaker	4.40%
California tonguefish	3.86%
white seaperch	2.97%
brown smoothhound	2.44%
speckled sanddab	2.08%
bat ray	1.72%
chameleon goby	1.19%
leopard shark	1.07%
Pacific herring	0.59%
threespine stickleback	0.59%
American shad	0.54%
pile perch	0.54%
big skate	0.42%
showy snailfish	0.42%
spiny dogfish	0.42%
longfin smelt	0.36%
Pacific tomcod	0.36%
brown rockfish	0.30%
cheekspot goby	0.30%
walleye surfperch	0.30%
lingcod	0.24%
Pacific lamprey	0.24%
yellowfin goby	0.24%
white sturgeon	0.18%
barred surfperch	0.12%
California halibut	0.12%
California lizardfish	0.12%
sand sole	0.12%
threadfin shad	0.12%
arrow goby	0.06%
bay pipefish	0.06%
black perch	0.06%

Common Name	Percent Composition
bonehead sculpin	0.06%
diamond turbot	0.06%
dwarf perch	0.06%
jacksmelt	0.06%
river lamprey	0.06%
starry flounder	0.06%
striped bass	0.06%
surf smelt	0.06%
topsmelt	0.06%
whitebait smelt	0.06%

Midwater Trawl

Station 101

Common Name	Percent Composition
northern anchovy	93.48%
longfin smelt	1.43%
white croaker	1.37%
shiner perch	0.95%
jacksmelt	0.69%
Pacific herring	0.57%
plainfin midshipman	0.47%
topsmelt	0.27%
bat ray	0.22%
Pacific sardine	0.12%
brown smoothhound	0.07%
striped bass	0.06%
bay goby	0.05%
American shad	0.04%
leopard shark	0.03%
English sole	0.03%
threadfin shad	0.02%
yellowfin goby	0.02%
Pacific pompano	0.02%
Pacific staghorn sculpin	0.01%
starry flounder	0.01%
chinook salmon	0.01%
night smelt	0.01%
chameleon goby	0.01%
speckled sanddab	0.01%
spiny dogfish	0.01%
whitebait smelt	0.00%
cheekspot goby	0.00%
rainwater killifish	0.00%
bay pipefish	0.00%
California grunion	0.00%
Pacific electric ray	0.00%
surf smelt	0.00%
threespine stickleback	0.00%
walleye surfperch	0.00%

Midwater Trawl

Station 102

Common Name	Percent Composition
northern anchovy	92.78%
topsmelt	2.21%
jacksmelt	1.99%
Pacific herring	1.65%
shiner perch	0.52%
bat ray	0.18%
longfin smelt	0.14%
California grunion	0.11%
white croaker	0.06%
American shad	0.05%
Pacific sardine	0.04%
bay goby	0.03%
yellowfin goby	0.03%
English sole	0.03%
striped bass	0.02%
brown smoothhound	0.01%
California halibut	0.01%
cheekspot goby	0.01%
threadfin shad	0.01%
leopard shark	0.01%
Pacific staghorn sculpin	0.01%
plainfin midshipman	0.01%
chinook salmon	0.01%
Pacific electric ray	0.01%
chameleon goby	0.00%
Pacific pompano	0.00%
surf smelt	0.00%
walleye surfperch	0.00%
barred surfperch	0.00%
bay pipefish	0.00%
California tonguefish	0.00%
diamond turbot	0.00%
night smelt	0.00%
Pacific tomcod	0.00%
rainwater killifish	0.00%
sevengill shark	0.00%
speckled sanddab	0.00%
spiny dogfish	0.00%

Common Name	Percent Composition
starry flounder	0.00%
threespine stickleback	0.00%
white sturgeon	0.00%
whitebait smelt	0.00%

Midwater Trawl

Station 140

Common Name	Percent Composition
northern anchovy	87.69%
white croaker	3.16%
shiner perch	2.29%
walleye surfperch	2.08%
English sole	1.31%
Pacific herring	0.89%
topsmelt	0.69%
plainfin midshipman	0.32%
bat ray	0.26%
longfin smelt	0.21%
jacksmelt	0.16%
bay goby	0.15%
Pacific sardine	0.13%
American shad	0.12%
striped bass	0.11%
whitebait smelt	0.08%
surf smelt	0.06%
yellowfin goby	0.04%
speckled sanddab	0.04%
threadfin shad	0.04%
Pacific tomcod	0.04%
night smelt	0.02%
Pacific staghorn sculpin	0.02%
California halibut	0.01%
big skate	0.01%
brown smoothhound	0.01%
pile perch	0.01%
Pacific pompano	0.01%
spiny dogfish	0.01%
bay pipefish	0.00%
California tonguefish	0.00%
chinook salmon	0.00%
diamond turbot	0.00%
eulachon	0.00%
leopard shark	0.00%
lingcod	0.00%
prickly sculpin	0.00%
queenfish	0.00%

Common Name	Percent Composition
sand sole	0.00%
starry flounder	0.00%
threespine stickleback	0.00%
white sturgeon	0.00%

Plankton Net

Station 101

Common Name	Percent Composition
northern anchovy	85.53%
Pacific herring	5.72%
arrow/cheekspot goby	2.82%
yellowfin goby	2.30%
goby type II	2.24%
unidentified fish	0.43%
chameleon goby	0.25%
cheekspot goby	0.16%
jacksmelt	0.14%
Pacific staghorn sculpin	0.10%
bay goby	0.07%
longfin smelt	0.07%
arrow goby	0.06%
unidentified goby	0.03%
white croaker	0.02%
longjaw mudsucker	0.02%
topsmelt	0.02%
diamond turbot	0.00%
prickly sculpin	0.00%
starry flounder	0.00%
bay pipefish	0.00%
English sole	0.00%
bonehead sculpin	0.00%
plainfin midshipman	0.00%
unidentified sculpin	0.00%
threespine stickleback	0.00%

Plankton Net

Station 102

Common Name	Percent Composition
northern anchovy	82.22%
Pacific herring	10.34%
goby type II	2.03%
arrow/cheekspot goby	1.80%
yellowfin goby	1.51%
unidentified fish	0.80%
jacksmelt	0.33%
Pacific staghorn sculpin	0.24%
chameleon goby	0.18%
longfin smelt	0.13%
bay goby	0.12%
topsmelt	0.12%
white croaker	0.06%
arrow goby	0.05%
cheekspot goby	0.03%
bay pipefish	0.01%
diamond turbot	0.01%
longjaw mudsucker	0.01%
English sole	0.01%
bonehead sculpin	0.00%
unidentified goby	0.00%
starry flounder	0.00%
threespine stickleback	0.00%
kelp greenling	0.00%
plainfin midshipman	0.00%
prickly sculpin	0.00%
speckled sanddab	0.00%
unidentified sculpin	0.00%

Plankton Net

Station 140

Common Name	Percent Composition
northern anchovy	36.69%
unidentified fish	34.05%
arrow/cheekspot goby	21.13%
goby type II	3.79%
Pacific herring	2.28%
yellowfin goby	1.09%
chameleon goby	0.11%
prickly sculpin	0.11%
bay goby	0.09%
Pacific staghorn sculpin	0.09%
English sole	0.09%
cabezon	0.07%
jacksmelt	0.06%
starry flounder	0.05%
California halibut	0.04%
striped kelpfish	0.04%
bay pipefish	0.04%
threespine stickleback	0.04%
unidentified sculpin	0.03%
unidentified prickleback	0.02%
longjaw mudsucker	0.01%
unidentified rockfish	0.01%
arrow goby	0.01%
topsmelt	0.01%
California tonguefish	0.00%
cheekspot goby	0.00%
diamond turbot	0.00%
longfin smelt	0.00%
plainfin midshipman	0.00%
speckled sanddab	0.00%
unidentified goby	0.00%
unidentified snailfish	0.00%
white croaker	0.00%

Beach Seine

Station 171

Common Name	Percent Composition
topsmelt	37.27%
arrow goby	22.58%
yellowfin goby	16.88%
jacksmelt	16.21%
Pacific staghorn sculpin	3.27%
northern anchovy	1.15%
striped bass	1.10%
threespine stickleback	0.68%
starry flounder	0.15%
rainwater killifish	0.14%
California halibut	0.09%
Pacific herring	0.07%
bay pipefish	0.06%
walleye surfperch	0.06%
diamond turbot	0.04%
surf smelt	0.04%
shiner perch	0.03%
splittail	0.03%
barred surfperch	0.02%
dwarf perch	0.02%
cheekspot goby	0.01%
English sole	0.01%
inland silverside	0.01%
longfin smelt	0.01%
pile perch	0.01%
plainfin midshipman	0.01%
American shad	0.01%
bay goby	0.01%
chameleon goby	0.01%
chinook salmon	0.01%
longjaw mudsucker	0.01%
Sacramento blackfish	0.01%

Beach Seine

Station 172

Common Name	Percent Composition
topsmelt	54.35%
jacksmelt	23.40%
Pacific herring	9.66%
Pacific staghorn sculpin	3.03%
northern anchovy	2.02%
yellowfin goby	1.79%
shiner perch	1.47%
arrow goby	1.01%
bay pipefish	0.84%
dwarf perch	0.76%
English sole	0.57%
threespine stickleback	0.26%
cheekspot goby	0.15%
diamond turbot	0.13%
chinook salmon	0.11%
striped bass	0.08%
rainwater killifish	0.08%
California halibut	0.06%
American shad	0.04%
bay goby	0.03%
barred surfperch	0.03%
surf smelt	0.02%
walleye surfperch	0.02%
inland silverside	0.01%
longfin smelt	0.01%
longjaw mudsucker	0.01%
pile perch	0.01%
plainfin midshipman	0.01%
splittail	0.01%
starry flounder	0.01%
striped kelpfish	0.01%
threadfin shad	0.01%
western mosquitofish	0.01%

Crab and Shrimp Data

Station 101

Common Name	Percent Composition
Dungeness crab	52.63%
Chinese mitten crab	42.11%
red rock crab	2.63%
graceful rock crab	1.32%
Pacific rock crab	1.32%
Common Name	**Percent Composition**
California bay shrimp	79.47%
blacktail bay shrimp	12.82%
blackspotted bay shrimp	3.20%
oriental shrimp	2.99%
Stimpson coastal shrimp	1.52%
stout coastal shrimp	0.00%

Crab and Shrimp Data

Station 102

Common Name	Percent Composition
Dungeness crab	43.75%
graceful rock crab	18.75%
Pacific rock crab	18.75%
Chinese mitten crab	12.50%
red rock crab	6.25%
Common Name	**Percent Composition**
California bay shrimp	58.75%
blacktail bay shrimp	34.23%
blackspotted bay shrimp	5.32%
Stimpson coastal shrimp	1.48%
oriental shrimp	0.22%
stout coastal shrimp	0.00%
unidentified Beteaus	0.00%

Crab and Shrimp Data

Station 140

Common Name	Percent Composition
Dungeness crab	73.27%
Chinese mitten crab	18.81%
Pacific rock crab	2.97%
red rock crab	2.97%
graceful rock crab	0.99%
yellow rock crab	0.99%
Common Name	**Percent Composition**
California bay shrimp	78.69%
blacktail bay shrimp	13.98%
oriental shrimp	6.13%
blackspotted bay shrimp	0.75%
Stimpson coastal shrimp	0.45%
miniature spinyhead	0.00%
unidentified Beteaus	0.00%
ridgetail prawn	0.00%
visored shrimp	0.00%